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THIRD SUGAR CONVENTION.

AN event of outstanding interest to the scientific sugar World will be the convention, scheduled to take place at Sourabaya, Java, in June, 1929, of the International Society of Sugar-cane Technologists. This organization, which includes in its membership leading men in their profession from various sugar-producing countries, aims to promote, by means of triennial conventions, the discussion of problems connected with sugar production in both field and factory.

The International Society of Sugar-cane Technologists was founded in August, 1924, during the sessions of the Pan Pacific Food Conservation Conference at Honolulu, Hawaiian Islands. A section of the Conference, consisting of sugar experts, held meetings to deal with the problems of the Sugar Industry. Those meetings aroused so much interest that a resolution was passed to establish a society of Sugar Technologists, which would meet in convention once every three years.

The second convention of the society was held in Havana, Cuba, in March, 1927, when fifteen sugar-producing regions were represented, namely: Argentina, Australia, Canada, Cuba, Fiji, Formosa, Hawaii, Holland, Java, Mexico, Philippine Islands, Porto Rico, Scotland, South Africa and the United States. At that convention, Professor Jeswiet of Wageningen was chosen as Chairman of the Society; and it was decided to hold the next convention three years hence in Java. The date of the Java Convention has since been advanced to coincide with the meetings of the Fourth Pacific Science Congress.

The Sugar Convention proper will be held from 7th to 14th June under the auspices of the "Algemeen Syndicaat Van Suikerfabrikanten." The necessary arrangements are in the hands of a commission consisting of two representatives of the Syndicate, the directors of the Experiment Station at Pasoeroean and of the sub-department at Cheribon, and the chairman of the three sections of the Association of Advisers of the Sugar Industry in Java. The chairman of this commission is Professor Ir. E. C. Von Pritzelwitz Van der Horst, chairman of the body of directors of the Experiment Station; while the secretary is W. D. B. H. Mulder who is also secretary of the Experiment Station.

The first three days of the Convention will be devoted to the discussion of general subjects, namely :

1. Development of the Java Sugar Industry in its Agricultural, Chemical and Technical aspects.
2. International regulation of the export of cane-sorts.
3. Irrigation.
4. Co-operation between factory and plantation.

The next three days are appointed for the meetings of the sections where agricultural, chemical and technical problems of current interest are to be discussed. On the last day the chairman of the sections will, at a general meeting, disclose the conclusions reached in the different meetings.

The second week will be devoted principally to excursions. The preliminary programme includes a visit to the Experiment Station, to some working sugar-factories and to important irrigation works.

It was recently remarked that the two preceding conventions bore distinctly the character of having originated from the Pan Pacific Food Conservation Conference where agricultural questions occupied a position of marked pre-eminence. Efforts will be made at the third convention to reflect more clearly the character of the society as being a body of sugar-cane technologists in a wider sense. Consequently problems of manufacture, factory control, &c., will be given a more prominent place than in the past. To that effect the list of subjects for discussion at preceding conventions has been augmented and will include the following :

Field practices such as cultivation, fertilization, tillage, &c.
Soil investigations.
Sugar-cane Varieties and related problems of seed selection and seedling propagation.
Insect pests of Sugar-cane.
Diseases of the Sugar-cane plant.
Protective quarantine measures.
Uniformity of sundry data for factory control.
Milling, imbibition, maceration and diffusion.
Methods of juice-clarification, criticism of the results obtained and those possible of attainment.
Criticism of the crystallizability of syrups and molasses and of the boiling schemes used.
Importance of colour and colourization of the product.
Boiler plant, fuel economy and fuel control.

Among various reports to be submitted at this conference will be that of the "Special Committee on Uniformity in Reporting Factory Data." The aim of this committee is to secure uniform terminology and uniform methods of analysis and factory control in the various countries represented. Should its proposals be adopted, they will be incorporated in a Book of Methods which will have the backing of the International Society. Those countries, and individual factories, which decide to adopt the proposed methods will then have their reports in such form that they can be readily understood and correctly interpreted, anywhere else. Many difficulties, however, lie in the path of adoption of uniform methods, owing to the widely varying conditions obtaining in the different sugar-producing regions. It is confidently expected, nevertheless, that useful and interesting results will follow open discussion by specialists thoroughly conversant with the subjects under review.

The language of the convention will be English, and possibly also Spanish. Papers read in the latter language will be translated by interpreters.

It is eminently fitting that Java should have been selected as the meeting place of a convention of sugar technologists at the present time. The Java Sugar Industry has, quite recently, demonstrated to the sugar world the value of scientific work, patiently and carefully conducted.

The very appreciable increases in yield, both in the field and factory, secured within recent years, although contributing to the world's overproduction of sugar, have placed the Java Sugar Industry in an enviable position from the economic point of view. Java is admittedly to-day, one of the few countries able to defy open competition in the world's sugar markets.

While admitting the fact that the Sugar Industry, as a whole, is passing through a crisis, which spells ruin to those sugar producers who, in the absence of naturally favourable conditions or Government subsidies, have neglected even the elementary principles of scientific management and control, one feels confident that the silver lining is waiting behind the clouds for others who take full advantage of the resources of scientific research and scientific management.

The inspiration and practical results which must necessarily follow such gatherings of specialists representing every branch of the industry, should ensure to progressive sugar producers at least that measure of prosperity necessary to the provision of employment for the many millions of natives of tropical countries dependent partly, or entirely, on the Sugar Industry.

The Imperial College of Tropical Agriculture is sending its representative, and it is to be hoped that sugar-producing regions within the Empire will be even better represented at the forthcoming Java Convention than they were at the Havana Convention of 1927.

The Malayan estates possess four up-to-date extraction plants, and it is interesting to note that palm oil from British Malaya has realized prices in advance of those paid for the African product. A preliminary survey of the various types of oil palm growing at the Department's experimental plantation at Serdang has indicated that the range of variation in this crop is sufficient to render profitable the selection of the best type of palm for plantation purposes.

AGRICULTURAL OFFICERS.

Their Functions in the Tropics.

[*Being an address given by Sir James Currie, K.B.E., C.M.G., to the College Staff and Students on 8th February,* 1929.]

IT is a great pleasure to be here, and to have an opportunity of meeting you all. I welcome, in particular, Sir Francis Watts, as first Principal, and take his presence as a great compliment. To see the College, to have an opportunity of grasping its objectives, of understanding its difficulties, of beholding the evolution of schemes which have been laboriously discussed, both by the Governing Body and by the Staff here, makes me thankful that at last I have been able to make this journey.

I sometimes wonder if the amount of time, labour and thought that has been put into the founding of this place, or the high hopes that are entertained for it, or the difficulties that have been surmounted in calling it into being, are realised by you all. Great administrators such as Lord Milner and Lord Lugard, distinguished Governors of these islands, Sir John Chancellor, Sir Samuel Wilson, Sir Horace Byatt, Cabinet Ministers like the Duke of Devonshire, Mr. Thomas and Mr. Amery, men of science such as your first Chairman, Sir Arthur Shipley, Sir David Prain, Sir John Farmer, Professor Wood, Mr. Hill, men of business like Sir William Himbury, Mr. Moody Stuart, Sir Edward Davson, have given their brains and their time without stint to your service.

Colonial Governments and Colonial taxpayers, first, foremost and most liberally, the Governments of the West India Islands, have contributed to its funds. The British taxpayer, as represented by the Imperial Treasury and the Empire Marketing Board, have done and are doing their full share. Great British industries, such as the users of sugar and cotton, have given liberal aid. So have some Banks and private firms.

Now, though the work of creation is still far from complete, a beginning has been made, and your founders look with confidence to you, in full confidence that you will justify their plans, their hopes, and their visions.

When considering what I was to say to you this morning, I reflected that the majority of you are not undergraduates, but men, and men who have already given proof of more than average capacity and industry. I speak on the assumption that you are convinced of the importance of the profession you have adopted, and that you believe implicitly in the possibilities of your work.

These possibilities we have attempted to make as broad as possible. The Governing Body and the Staff here have set themselves to build up an Institution which will be a centre alike of teaching and research. We attempt to avoid duplicating work which can be efficiently and more economically carried out at home.

We are convinced, however, that in the main, tropical problems must be studied in a tropical environment. We consider that the average University graduate has experienced rather a surfeit of lectures, and that he has reached a stage at which direct instruction is profitably supplemented by actual association with specific pieces of research work under the guidance of experienced workers.

The majority of the Professional Staff have got important work in hand, in which you are privileged to share. So has the Cotton Research Station of the Empire Cotton Growing Corporation, which is at your door. The Empire Marketing Board also realise that the College furnishes a convenient centre from which much important investigation can be conducted, and you are thus provided with additional facilities for the observation of high class research work, if you are worthy of being infected with its spirit. We welcome members of the Agricultural Staffs of various Colonies. We hope that they will benefit by their term here, and in any event, you learn much from them as regards the conditions under which you will have to work.

I believe that in the main, during the twentieth century, it is your type of work and its results that will justify some measure of alien guidance in the Tropics. Be not deceived; such guidance is on its trial to-day. Tested by the success that has attended our efforts to place scientific methods at the service of those who look to us for help, we British people have but moderate ground for satisfaction. We have concentrated on administration; we have lacked faith in what science has to give us.

I have talked recently to two friends, each holding a high official position, each recently returned from extensive Empire tours. Both of them have had unique opportunities of arriving at correct conclusions. They have both told me that, among much to justify legitimate pride, they blushed when they contrasted the economic development, based on scientific and medical research in countries within the orbit of the British Empire, with the state of things obtaining under many foreign flags. I would like to cite another and different type of witness. I wonder if most of you have read a book I brought with me on the voyage out, and found most interesting reading. It is a collection of fugitive essays on scientific subjects, and has been given the title of "Possible Worlds." The author is Mr. J. B. S. Haldane, now of Cambridge University. The object he has set before himself is, in his own words, that the average man should attempt to realise what is happening to day in the Laboratories. In one brilliant essay, "Nationality and Research" is the name the author gives it, he tells us that in Europe, two small nations, Holland and Denmark, lead in the output of scientific work per million inhabitants. He adds that they are, incidentally, two of the healthiest nations in Europe, and are both quite rich, though almost devoid of mineral wealth. This is because they are successfully employing biology, Denmark to her own Agriculture, Holland to the development of her Empire, which sets the example to the world in Tropical Agriculture and Hygiene.

Now I am not satisfied with that criticism, especially since I entertain no doubt as to its truth. It is all very well to talk about British Administration and its excellence, the integrity of British justice, and the historic glories of the Privy Council. A hungry population intent on a much higher standard of living, cannot exist on such things, indispensable preliminaries to social well being though they are.

To listen to many eminent officials, one would almost think that political Institutions were ends in themselves. I wrote to a distinguished Tropical Administrator the other day, and told him that I would yet find his subjects starving amid political perfection. I think he considered the criticism blasphemous.

But even in much pre-occupied Great Britain, there has been a stirring on the face of the waters, and an increasing comprehension of vital needs. More has been done in the Colonial Office during the last five years than in all its previous existence, to make up the costly leeway, thanks, in the main, to the present Secretary of State and his enthusiastic and informed Parliamentary Secretary, Mr. Ormsby Gore. A few years ago a strong Committee, presided over first by Lord Milner, and on his death by Lord Lovat, was set up to take stock of the situation, and the result was a remarkable document called the Lovat Report. If its recommendations can be carried into effect, a great weakness and a great reproach will be removed.

I need not draw attention to the political and financial difficulties that will have to be surmounted before adoption is possible. One tangible result has already happened. Mr. Stockdale, known to many in Trinidad, and now, I am glad to say, a Governor of the College, is installed in the Colonial Office as Assistant Agricultural Adviser.

I do, however, state without fear of contradiction, that if the Report as a whole were adopted to-morrow, the Staff does not exist to man the various services and Research Institutions which are indicated as essential. It is to you and to your successors that we, in the main, look to, to fill this gap worthily. The whole Tropical world is calling; no Christian missionary, Jesuit, Moravian, Presbyterian or Anglican, no Mohammedan sheikh, no Bhuddist Mahatma, ever has had a greater opportunity presented for work and sacrifice. And this is applicable to all, graduates and post-graduates alike.

And the particular fascination of the work is, that it benefits not only the particular people among whom the worker's lot is cast, but the whole world fabric. Take a case in point. I have seen during the last twenty years arid lands south of Khartoum redeemed from barbarism and destructive fanaticism, caused in the main by degrading poverty. A contented population is now putting these lands to productive use, primarily to their own benefit, but in a scarcely less degree to that of the workers of Bolton or Lyons.

I will not, however, talk further on the direct possibilities of the work that is going on here. If you did not agree with me you would not be in Trinidad to-day.

Before I conclude, I am going to say one word on some of what I may term the extraneous difficulties that many of you will certainly encounter, especially in the later stages of your careers. When I talk of scientific problems and the application of the scientific method, outside certain narrow limits, I walk by faith and not by sight. When I talk of political and administrative difficulties, I feel on surer ground. At all events, what I say is the outcome of thirty years' work and experience.

What I would urge you to remember is this, that if, in the various spheres of work to which you will shortly be transferred, you fail to keep alive and sensitive to the administrative and political problems with which the East is seething, your work will be shorn of much of its possibilities of usefulness.

Have you ever asked yourselves what are the ultimate objects that a College like this exists to serve?

The late Lord Morley, in a magnificent address which he gave some years ago to the students of Manchester University, suggested that a primary object of their University was "to weave the strands of knowledge into the web of social progress." If you accept that as an adequate definition, you cannot attain your maximum usefulness unless you provide yourselves with a working knowledge of the history, the political and economic conditions, and if possible, the language, of the particular country in which you find yourself at work. Do not hug the illusion that the political and economic questionings which are troubling Africa and Asia are passing phenomena, or that you will be unaffected by them. The problem that to-day confronts India and Ceylon, will to-morrow face West Africa and the Sudan. My own view is, that in the near future, in many parts of the British Empire, great changes will be seen, so far as the organisation of scientific work is concerned. If the Lovat Report be adopted, a good deal else may in time follow. State Departments of Agriculture organised on Bureaucratic lines may be transformed. The antiquated Pension system may disappear in favour of something more elastic. Research and administration may in time be grouped round Institutions which the Report proposes to set up, and conceivably round various great industrial organisations, such as the Empire Cotton Growing Corporation and the Rubber Growers' Association.

These institutions and organisations, though liberally supported by the state and the various Governments concerned, will be independent and free. State action will limit itself to co-ordinating effort. By some such means I would hope that the support and interest of the people among whom they work may be assured, with beneficial reactions in all directions. Otherwise there is a

SUGAR PRODUCTION IN ANTIGUA.

(*See page* 105)

(*Photographs published by the courtesy of the Imperial Institute.*)

Cutting and loading canes in the field.

Loading canes on trucks.

SUGAR PRODUCTION IN ANTIGUA.

Transporting Canes.

Antigua Sugar Factory, Gunthorpes.

real danger that scientific work may become identified with particular theories of political or racial ascendency.

In that case, as political changes take place, the toll that politics take of economics, may be heavy indeed. This has already happened in Egypt, to the detriment of the material interests of the community. Of India I have scanty knowledge, but I have read the Linlithgow Report, and I know a little of the rise and, I fear, the partial decline, of the magnificent Imperial Department of Agriculture which Lord Curzon inaugurated.

All such recent events will repay your study. The Butler Report on Ceylon is available, and the Report of the Simon Commission, when it appears, will be of supreme interest. Much too may be learned from a study of the policy followed by the Dutch in their magnificent Empire in the East, with its fifty millions of people.

In this connection, Mr. Ormsby Gore's Report on his recent far Eastern tour, is well worth careful reading.

Finally, it is unnecessary to remind you, the majority of whom are heirs to the traditions of British Universities, that research knows no colour bar, and that a distinctive feature of British University life has been the absence of nationalistic feeling.

What the contribution of the East may be in the future to the cause of research, is veiled from our sight. Japan, with such work only in its first generation, is already fully abreast of most European countries. China, under American guidance, is starting, and India is fairly begun. It has already produced one of the outstanding mathematical figures of the twentieth century. And all over Africa and Asia foundations are being laid; in Beyrouth, in Palestine, in Khartoum, in Ceylon, in Singapore, to take examples known to me.

While the first and paramount duty of each of you is to become a master of his own craft, a comprehensive understanding of the problems I have touched on is no less essential. Equipped intellectually and technically, as I have tried in these few words to indicate, you will be fitted to take part in the task, on the success of which the material, moral and spiritual progress of the world in no small measure depends. That task is the justification of the West in the eyes of a questioning and awakening world.

CITRUS IN URUGUAY.

The growth of citrus plants is carried out in Uruguay in the Salto district where 250 citrus groves cover an area of some 5,000 acres. It is slowly but continuously extending. The production is 250,000 q. (24,605 tons), which is sufficient to allow a margin for export after supplying the home market. The Tangerine variety of Mandarine, which is most resistant to locust attacks, is chiefly grown.—(*Revista de la Federacion rural* V. IX, N. 103.)

EXPERIMENTAL ERROR.

A Survey of Recent Advances in Statistical Method.

Concluded.

BY E. J. MASKELL, M.A., Ph.D. (Cantab.)
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The Analysis of Yield. Quantitative Relations.

THE types of experiment so far discussed have been concerned mainly with establishing the existence or non-existence of favourable effects on yield, and with estimating the range of magnitude of these effects. For variety trials such information is usually sufficient, so far as yield is concerned. Other considerations will, of course, play a part in determining whether the higher yielding varieties are recommended for general use. In manurial trials and in experiments designed to study the physiological bases of yield variation the problem cannot usually be left at this qualitative stage. The quantitative relation between yield and the intensity of the factor or factors in which we are interested must come under investigation. It is in this field of enquiry that the increased precision obtained by the more recent methods of planning and analysing experiments is likely to yield its most valuable results. Two aspects of this quantitative investigation call for some comments, namely (1) the relation between yield and the intensity of a factor which affects it; (2) interaction between different factors.

The yield-factor relation.

In spite of the economic importance of the relation between the amount of manure applied and the resulting increment of yield it is the exception rather than the rule to find manurial experiments in which the quantity of manure is varied in a regular manner. This is undoubtedly due, in part, to a fear lest the attempt, with a limited number of plots, to determine the wider question, should result in a failure to establish significant effects at any concentration of manure. As we saw in an earlier section, however, widening the range need not involve loss of accuracy in determining the main question. Take, for example, a manurial experiment in which only 16 plots are available for testing a certain manure A. Making the simplest test we should have eight plots without A, ($0A$), and eight plots with unit amounts of A, ($1A$). We can make the experiment quantitative by having four plots each of $0A$, $\frac{1}{2}A$, $1A$, $1\frac{1}{2}A$. In the first case we determine the main question by comparing the eight $1A$ plots with the eight $0A$ plots. In the second case we may compare the mean of the eight plots $1A$ and $1\frac{1}{2}A$ (four of each) with the mean of the eight plots $0A$ and $\frac{1}{2}A$ (four of each); or, if the manurial effect appears to reach its maximum already at the $\frac{1}{2}A$ amount, we may compare the mean of the twelve $\frac{1}{2}A$, $1A$, $1\frac{1}{2}A$

plots with the mean of the four o A plots. Thus the main question may be determined in the more complex experiment with approximately the same accuracy as in the simpler experiment, while we may in addition obtain some information as to the relation between yield and quantity of manure.

Assuming that the main question—the existence of a manurial effect—is answered in the affirmative, the *general form* of the yield-factor relation may be tested in a simple way, again employing means of eight plots, thus ($\frac{1}{2}$ A+1 A) minus (o+1$\frac{1}{2}$ A). If each additional increment of manure produces a progressively smaller increment in yield (Law of Diminishing Returns) this difference will be positive. If, on the other hand, over the range investigated, the yield-factor relation is one of increasing returns, the difference will be negative; while if each increment of manure produces approximately the same increment in yield the difference between ($\frac{1}{2}$ A+1 A) and (o A+1$\frac{1}{2}$ A) will be negligible.

Thus by a slight increase in complexity the relatively simple manurial experiment can yield additional information of great value without loss of accuracy on the main point. For a precise determination of the yield-factor relation a greater range of intensities and the larger number of plots would naturally be required. A number of mathematical formulae are available for describing this relation. For a recent discussion reference may be made to papers by Briggs(1) and Balmukand.(3)

Interaction between different factors.

Perhaps of prior importance to the problem of the exact form of the relation between any one factor and yield, is the question of the effect of one factor on the response shown to another. Unless we can establish some generalisations as to the way in which different factors interact, intensive work on the separate yield-factor relations must be very largely wasted. Yet surprisingly little information as to the nature of this interaction exists, even in the restricted field of manurial or nutrient effects. Experiments in which manures are combined in a number of different *ratios* are not uncommon, but they are seldom arranged in such a way as to make either the major effects of the separate manures, or the way in which the different manures interact, easily ascertained. The type of plan required for a complex experiment of this type has already been indicated in an earlier section. The whole range of intensities for each manure should be repeated at each intensity of the others. Thus a fairly simple test of the interaction between a nitrogenous manure, N, and a potash manure, K, each in amounts of o, 1 and 2 units, would involve the nine combinations.

oN oK	oN 1K	oN 2K
1N oK	1N 1K	1N 2K
2N oK	2N 1K	2N 2K

Not only is such an arrangement admirably adapted for the mathematical analysis, but the general nature of the interaction may be readily appreciated from the run of the yield figures in the rows and columns of the 'gridiron' set out as above, or by plotting the data as a set of three curves. Interaction between three manures would require 27 combinations—too large a number, perhaps, for ordinary field work—but for the purpose of establishing the general principles of interaction of factors the labour would be well repaid. Especially is this true for work on pot or water cultures. Previously the more important attempts at studying interaction between nutrients in pot or water culture have been made on the triangular three-salt plan which has found great favour in America. From five to seven different intensities of each salt are employed, but the total amount of the salts given is fixed, so that increase in any one necessitates a decrease in one or both of the others. The result is a set of data extremely difficult to analyse in any precise terms. Further progress would undoubtedly be made if the number of different intensities of each salt were somewhat reduced and each intensity of one salt were repeated in combination with each intensity of the other two.

The types of interaction that are likely to occur may be briefly indicated. For some of them mathematical formulae are already available; for others only a rough formulation can be made. But the most urgent need in this field of work, at present, is to know what *type* of interaction is characteristic of different groups of factors, manurial and other. It will be readily appreciated that the analysis of the effect of weather conditions, which involves interaction between a number of uncontrolled variables, depends in a similar way on knowing how to combine the effects of the separate weather factors which we measure. Controlled experiments of the 'gridiron' type here discussed may furnish valuable clues to the methods to be employed in this analysis.

Types of interaction.

(1) No interaction: each factor produces its effect independently, or Yield = $A+B+C+$where A, B, and C, &c. are determined separately by each factor.

(2) A product relation; the *percentage* increase caused by a given increment of any factor is the same for all intensities of the other factors: or Yield = $A\times B\times C\times$, &c.

The statistical analysis of a case of interaction shewing this product relation has been discussed by Fisher and Mackenzie.(5)

(3) Interaction of the "Limiting Factor" type. In the extreme case represented by Liebig's "Law of Minimum," the favourable effect of one factor, A, disappears entirely when another factor, *e.g.*: B falls below a certain value. A more common case, which it is here suggested may be referred to the general "Limiting Factor" class, is for the *percentage effect* of a given increment of A to be very low when B is low but to increase as B increases. An example is the interaction between mineral manures and nitrogenous manures on, at least some crops. On the classical Broadbalk

wheat plots, for instance, the percentage increase due to a given application of mineral manures is far greater in the presence of ammonium sulphate than in its absence. For interactions of this type the writer has suggested that it may be useful to analyse the yield as the resultant of a process working against a series of resistances. Thus

$$\text{Yield} = \frac{I}{R_A + R_B + R_C + R_D, \text{ \&c.}}$$

or

$$\text{Reciprocal of yield} = R_A + R_B + R_C + R_D, \text{ \&c.}$$

This formula has recently been applied to the interaction between potash and nitrogen manures by Balmukand.(3)

Other types of interaction exist but have not yet been precisely formulated. It is clear, however, that there is a considerable field for the application of the newer methods of experimental planning in this question of the effect of one factor on another.

Planning of field trials. Some general considerations.

The importance of deciding what general questions are involved in any trial, and of arranging the experimental scheme so that these can be clearly tested has already been discussed. It may be convenient here to refer to certain general considerations affecting the field plan as distinct from the experimental scheme.

Blocks.—It is worth noting that the method of randomised blocks makes it possible to utilise land which would be unsuitable for the older type of chessboard, owing to the existence of physical features such as 'ravines,' which would cut into a compact set of plots. For, while it is an advantage to have the whole experiment as compact as possible, the blocks, being essentially independent units, need not be *absolutely* contiguous. Space can be left between them to accommodate such features as ravines.

Size and shape of plot.—The size of plot used will depend, of course, on what is known about the magnitude of the field variation, and the degree of accuracy desired. Again, no general rule can be given as to shape of plot. The square shape has the advantage that the edge effect is a minimum, but for certain crops the long plot has practical advantages, which outweigh this consideration. Statistically the long plot has no advantage over the square plot, *unless the direction of greatest soil variation is already known* and the plots can be elongated in that direction. A number of investigators have claimed that the long plot gives a lower standard deviation : but examination of the data shews in most cases that this is true only for the particular direction in which the plots were elongated. If the long plot has a lower standard deviation when elongated, say, from north to south it usually has a greater standard deviation when elongated at right angles, from west to east. Advantage may be taken of this fact, if the direction of soil variation is known, the *plots* being elongated along the fertility trend, and the *blocks* of plots elongated across the fertility trend. But, where nothing is known of the soil variation, it is best, other considerations being equal, to make both plots and blocks as compact as possible.

Random arrangement.—The random arrangement of treatments or varieties within each block, which has been emphasised in the preceding sections, may perhaps conflict with practical requirements in certain cases. It is doubtful, however, whether these considerations can ever be strong enough to out-weigh the importance of maintaining that element of chance which is essential if valid predictions are to be made from the results. In manurial experiments there is probably no reason for not adopting a random arrangement. In the case of variety trials, particularly with cereals, Engledow and Yule (2) have put in a strong plea for repetition of varieties in a systematic order. A systematic order, as they point out, makes sowing easier to carry out and to check, and, still more important, when the crops are growing it makes convenient that appraisement by the eye of behaviour during growth which is an important part of the art of plant breeding. It may be urged, however, that, with the subdivision of the experiment into blocks, accurate sowing is somewhat simplified, even when there is a random order within the block, and this difficulty should not be insuperable. Moreover, especially with tropical crops such as cotton, the development of a technique for metrical observations on the growing crop, makes it possible, if not desirable, to dispense with a systematic arrangement for 'convenience of observation.' For, if the yields are biased by a systematic arrangement, as may well happen, so also the behaviour during growth may be biased. It may be noted that Bailey, working with cotton in the Sudan (4), reports success with the adoption of a random arrangement of plots, combined with standardised serial records of the behaviour of the varieties.

In experiments undertaken to establish the broad principles of yield variation in response to different factors and in particular in any work dealing with the quantitative relation between factor and yield, random arrangement of the uncontrolled variation is a first essential for accurate work.

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PARASITOLOGY IN THE TROPICS.

Being an Address delivered before the Science Club, Trinidad, B.W.I., on the 25th October, 1928.

By Thomas W. M. Cameron,

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The diseases of tropical lands—and this is true for animals as well as man—fall in general, into two separate classes; those associated with any primitive civilisation and those peculiar to warm climates. The first group of diseases are mainly bacterial and will disappear (as, say, small-pox and plague, glanders and rabies are disappearing from European countries) as civilisation progresses and hygiene and preventive medicine commence to play their real part in tropical life. The second group—the true tropical group—comprises those diseases caused by animal parasites or conveyed by animal vectors from one host to another. This is only a rough and ready classification it is true, and it omits many of the minor causes of disease in the tropics—such as the fungi and so on—but it draws attention to the essential differences between tropical and temperate medicine and above all to the importance of the vector and the intermediate host.

Modern tropical medicine commenced only some fifty years ago when Sir Patrick Manson demonstrated the part played by the mosquito in the transmission of human filariasis. It must not be thought, however, that Parasitology—or Medical Zoology as it is now often called—is a new branch of science. Far from it. Indeed as a cause of disease, the animal parasite was recognised many centuries before Pasteur fathered the modern science of Bacteriology.

Archaeology is continually unearthing new records of the ravages caused by parasitic worms. Bilharziasis was recognised in Egypt in the times of the early Pharaohs and the disease is still recognisable in mummies over 3,000 years old. The fertile crescent of Asia Minor teems with references to parasites and Moses was well acquainted with their effects. The fiery serpents of the wanderings were Guinea worms and the symbolical raising of a brazen serpent on a staff was a practical demonstration of a method of removing these worms which is still practised by the natives of these very districts. The admonitions against the consumption of pork were probably associated with the dangers of infection with trichina worms and tape worms. Other equally old records are sufficiently common to show the antiquity of the subject. Nor is the conception of the intermediate host a new one: the ancient Indian sages ascribed fevers to the bites of mosquitoes. In more modern times, Küchenmeister (1851), showed that human tape worms had an intermediate stage in pigs and oxen; Fedtschenko, following advice given to him by Leuckart, discovered the larvae of the Guinea worm in Cyclops in 1870 and a few years later both Weinland and Thomas found the snail carrier of the liver-fluke of sheep. It is with Sir Patrick Manson, however, that the modern conception of the insect vector of disease first found definite expression and it is from this time that modern parasitology, and with it modern tropical medicine, became active instruments in the opening up of the hot parts of the world.

Patrick Manson worked in Amoy in China, a district where about 10 per cent. of the inhabitants harboured the parasitic worm called *Filaria bancrofti* and where a considerable proportion suffered from Elephantiasis. This parasite lives in the lymphatic vessels and its larvae are discharged into the blood-stream. They have no normal method of egress from this virtually closed circuit, and Manson, knowing that Nature, callous though she may be of the individual life, always looks after the race, saw that these larvae must be removed from this closed circuit by some external agent and he concluded that this agent must be a biting insect. He observed also that these larvae—or microfilaria as they are called—are almost entirely absent from the peripheral blood-stream during the day but are present in very large numbers at night; so he further concluded that this insect vector must be a night biting one. A survey of the distribution of the disease and of the available insects, led him to experiment with one particular species, and after much patient work he was able in 1878-79 to demonstrate that the microfilaria were abstracted from the blood by a species of Culex (either *C. fatigans* or *C. pipiens*) in which an essential developmental cycle took place before they became infective to man again. Manson at that time believed that man was infected by swallowing the larvae which had escaped from the mosquito into water and it was not until some years later that Low and others were to demonstrate that the larvae escaped from the mosquito during the act of sucking blood and actually penetrated the skin.

It is from this date that the importance of the insect vector of disease began to be realised and that modern parasitology may be said to have begun.

The next chapter in the story comes from the United States. In the last decade of the nineteenth century, a disease was introduced into the Northern States from the South—a disease of cattle which accompanying the apparently healthy animals from the South, remained to destroy those in the North. That disease—best known perhaps as Texas Fever—was one of the first of the major problems set to the recently constituted Bureau of Animal Industry and its solution was due to the clear thinking and experimentation of two young men—Smith and Kilborne. After four years of work in the Laboratory and the field they demonstrated conclusively in 1893 that the cause of the disease was a minute pear-shaped animal organism living in the red blood cells; and that it was

conveyed from cow to cow by means of the cattle tick which passed the parasite through the egg, from the infected mother to the infective young. It was a piece of work with far reaching effect. It brought under control a group of diseases of immense importance to stock breeders all over the tropical world—a disease, incidentally, which is present in Trinidad and, but for the watchful supervision of the local Veterinary Department, would play havoc with the stock. More than that, it helped to point the path to the control of malaria, of sleeping sickness, of yellow fever and many other diseases of both man and his animals. It is our second milestone on the way to an ideal which is still far distant.

The next few milestones follow fast, however. The story of malaria has been often told; how Laveran in 1880 discovered the parasite; how Manson, remembering his experiments with *Filaria bancrofti*, formulated his famous mosquito hypotheses and how Ross under his inspiration commenced in 1895 that work in India which, first with bird malaria, later with the human form, proved that certain species of mosquitoes were the essential intermediate hosts of the parasites. The difficulties and the disappointments which Ross had to overcome are vividly portrayed in his own recent "Memoirs," and need not be further dealt with here.

In Africa, meantime, the path was being steadily surveyed. David Livingstone in the very early days of Darkest Africa's exploration had described Tsetse fly disease in stock and in 1880 Evans had described the trypanosome parasite of Surra, but it was not until 1895, when Ross was setting out to discover the life-history of the malarial parasite, that David Bruce commenced the series of investigations in Africa which culminated first of all in the complete story of Nagana and later, after Castellani had found the trypanosome in a patient, that too of human Sleeping Sickness.

In the New World, too, the work was going on. Findlay in Cuba had for some years preached the gospel of Stegomyia, but not until 1900 when Reed and Carroll and Lazear and their colleagues came was the story substantiated, in part at least, for it is still unsolved. Hindle recently has prepared a vaccine which may hold this scourge in check but it was on the work of Reed and Lazear that Gorgas was able to clear the atmosphere of the Panama Canal from the dreaded taint of "Yellow Jack." This triumph of engineering science in the tropics is the direct result of one of the greatest triumphs of applied medical science.

Meanwhile in Egypt, the trail was being blazed by Arthur Looss a careful and thorough German worker. He had come to teach Medical Parasitology and while engaged in this work he commenced a monograph on the human Hookworm. While making his drawings one day, a drop of a culture accidentally dropped on his hand. The pricking sensation which resulted was considered as a purely local "itch" until later he found himself heavily infected. Hookworm had entered the body through the unbroken skin! This was a fact of considerable practical importance, not only in Hookworm infestations—(and it is estimated that about a quarter of the inhabitants of the globe harbour these parasites)—but in that other helminth scourge of Egypt—the Blood Fluke.

In Egypt and throughout Africa generally there live in the blood of man two species of flukes called Bilharzia worms. In Japan and parts of China lives a third species, but it is more catholic in its tastes and inhabits the blood-stream of a variety of other hosts as well. Until 1912 the life-histories of these parasites were quite unknown. It was known, however, that in the case of other flukes an intermediate host—a snail—was necessary and that in this host a process of asexual multiplication took place. Although many prominent parasitologists tried to find such a host for the Egyptian blood flukes, none had been successful, and Looss, who occupied at that time an almost unique position in the parasitological world, declared that the Bilharzial worms were an exception to this general rule and required no intermediate host. The larval forms, he declared, which emerged from the egg penetrated the skin of man and these developed directly in his liver. A species of cestode in Egypt was known also to develop in man without an intermediary and this together with the great prestige enjoyed by Looss caused this hypothesis to be adopted as fact by many workers.

In Japan, meanwhile, in 1908, Fujinami and Nakamura had demonstrated that *S. japonicum* infection in animals followed contact with infected water in infected neighbourhoods, while in 1913, Miyairi was able to infect experimentally a local snail (described at the time, wrongly, as Limnaea) although no details of this work were then available. Looss in 1914, accepted this work, but maintained that it did not apply to the African species. Leiper, in London, was unable to agree with Looss and in 1912, he planned to tackle the problem in a new way. Comparative parasitology suggested that the Egyptian flukes might experimentally infect monkeys. There was no proof that they could however, and so a negative result would be inconclusive. Moreover, large numbers of monkeys would be necessary to test all the larval flukes found in snails in Egypt.

Now in these larval flukes, there are certain characters which are permanent and appear in the adults—notably in the digestive system. Most flukes have surrounding the first part of the alimentary canal a small muscular pharynx. This is absent in the Bilharzia worms. If it were also absent in their larval stages, a valuable morphological clue would be available for its identification. But certain other flukes have this pharynx fused with the oral sucker, although both were separate in the larvae. Was this the case with the Bilharzia worms? Inference was useless to decide this point and actual observation

was necessary. Fujinami's experiments suggested that this observation could be made on the Far Eastern species.

It was not until the spring of 1914, however, that Dr. Leiper and Surgeon Atkinson, R.N., set out for China. In the few months available prior to the outbreak of war, they were unsuccessful in finding suitable material in the Yangtse Valley. The war brought field work automatically to an end and Atkinson rejoined the Navy. Leiper himself journeyed over to Japan to the district where Fujinami had conducted his original investigations; collected the common snails from the endemic fields; and with the aid of a travelling microscope examined the cercaria. The infective larvae of the Japanese blood flukes had no muscular pharynx! Armed with his morphological clue and a number of parasitised snails, he returned to Shanghai where a few laboratory bred mice were infected; and so home to London, his immediate objective achieved. Meanwhile, of course, Miyairi had, quite independently, discovered the exact rôle played by these same snails in the South Island of Japan.

Accordingly in 1915, Leiper proceeded to Egypt to search for similar forms. The knowledge that a particular snail was implicated in Japan was of no assistance in Egypt—rather the reverse as subsequent events showed, because the intermediaries of African forms proved to belong to an entirely different order of mollusc—as far apart from the Japanese forms as lice are from mosquitoes. The morphological clue alone was of value. By its aid four different larvae were isolated. Two of these were discarded for epidemiological and other reasons. The other two were used to infect monkeys and they proved to be the infective stages of the two Bilharzial worms which cause Bilharziasis of man in Egypt. No experiments were made with any other cercaria.

I have dealt with this milestone in some detail, partly because it had never—even inadequately—been properly described and partly because, although absent from Trinidad, one species (*S. mansoni*) has been brought over from Africa to the West Indies and tropical South America and I have been privileged to make a discovery which might have profoundly altered the original investigations—namely, that it occurs naturally in monkeys in the island of St. Kitts—monkeys which originally were imported from Africa many years ago. It is probable that the other African species also (*S. haematobium*) which is not present in the New World will be found naturally in monkeys because Leiper found these animals were easily infected experimentally. This fact too, has another significance, since a reservoir host such as this makes the possibilities of an eradication campaign more hazardous if, as has been proposed, it is to be carried out by the injection of drugs into carriers of the parasite.

There is not time now, however, to go into these questions of preventive medicine, important as they may be, or to tell how the remaining milestones on our way were erected; how the flea was found to carry plague; the louse, typhus and French fever; ticks, relapsing fever and other diseases; the cone-nose bug, South American Trypanosomiasis, or to describe the variety of biting flies which carry other parasites to man and animals in the tropics. Much ground has been covered since 1879, although the end of the trail is still far in the distance.

These brief epitomes which we have considered show how the opening up of tropical countries depends on parasitology. The great killing and debilitating diseases of the world include Syphilis, Tuberculosis, Malaria and Hookworm. The first two are cosmopolitan in their distribution, although the first was probably New World and the second Old World in its origin. The latter are exclusively diseases of warm countries and must count their annual victims in millions. When we add to these, diseases like Yellow Fever, Plague, Sleeping Sickness and so on, it seems marvellous that man—especially white man—can live in the Tropics at all. In the good old days, in fact, he didn't. The West Coast, for example, became the "White Man's Grave." At the beginning of this century the mortality among white officials there was nearly 30 and the invaliding rate nearly 70 per 1,000. These figures in 20 years dropped to under 10 and under 20 respectively, simply through the application of the lessons taught by the parasitologist. The same development of hygiene and medicine is proceeding elsewhere throughout the tropics, but much has still to be done. Until the hot parts of the world are safe for the white man, civilisation must be retarded. Moreover, the effect of parasites in the coloured workers must be reduced. Malaria and Hookworm and other parasitic diseases are less acute in natives, but their effect on working ability and on stamina is enormous. No worker with chronic malaria, with chronic anaemia due to Hookworm, with chronic schistosomiasis, or indeed with any chronic infection can produce to his full capacity. Equally important are the effects on domestic animals. Imported animals quickly die from new infections; witness for example the difficulty of introducing stock into Trinidad on account of Red Water or of taking animals through the Fly belts in Africa. The native animals all suffer from chronic parasitic diseases and this causes a steady drain on milk, meat and work production. Without efficient animals, agriculture, the basis of all tropical prosperity and expansion, cannot flourish. In time, may be, mechanical "horses" may replace live ones, tinned meat and milk and butter replace the real article, and preserved eggs replace the natural product. But that time is not yet, and tractors and tinned food at present only serve to accentuate the need for efficient live stock.

There is obviously much to be done, although the activity in certain branches of parasitology is greater than ever before. Other pathways are now only just being explored, and new tracts being laid down.

But all these researches imply a close co-operation between workers in the laboratory and workers in the field. Without that, progress is enormously hampered. The field workers must be able to diagnose infections and pick out the important aspects to be investigated. The laboratory workers then must find out all about the causal organism, its bionomics, the weak points in its armour and how these may be best attacked. The information then received is applied in turn by the field worker, and another step forward is made. In that way only, is real progress possible.

THE PRINCIPAL'S REPORT, 1927-28.

[*Copies of the Prospectus for* 1929-30, *the Principal's Report for* 1927-28 *and the Register of the Imperial College of Tropical Agriculture may be obtained on application, from the Secretary, Imperial College of Tropical Agriculture,* 14, *Trinity Square, London, E.C.* 3., *or from the Registrar, Imperial College of Tropical Agriculture, Trinidad, B.W.I. For the convenience of readers extracts from the Principal's Report for* 1927-28 *are published below.*]

Various members of the staff visited the neighbouring colonies in the Caribbean area during the year. Professor Ballou made several tours and visited most of the islands in the Leeward and Windward groups on more than one occasion. Mr. H. H. Croucher paid a special visit to St. Lucia in July to investigate sugar-cane soils. Dr. Wardlaw, who visited the same colony in June in connection with Panama Disease, also made a prolonged tour later, which not only included British Honduras and Jamaica, but also large banana producing areas on the Spanish Main such as Limon, Panama, and Santa Marta.

Professor Wood accompanied by Mr. Baker paid a visit to St. Vincent in the Christmas vacation with the Cotton Corporation students, and Mr. Wright also visited that island at the same time and made a preliminary enquiry into the economics of Sea Island cotton cultivation. I visited British Guiana in the Easter vacation and was accompanied by Professors Wood and Cheesman, Mr. Baker, and twenty-two post-graduate students. The party had been specially invited by the local Agricultural Department, and thanks are due to the excellent arrangements made by Professor J. S. Dash and his staff whereby the College party were enabled to see a great deal during the relatively short time available.

The total number of students attending the college was forty-six. Of these sixteen were attending the diploma courses, twenty-six were post-graduates, and four attended for short periods as special students.

Of the sixteen diploma students seven joined in October and took the first year course. All these passed with the exception of two. The three in the second year course all passed. The third year course was taken by five men. Three of these were taking general agriculture, and all passed.

Of the post-graduates seventeen were Colonial Office nominees, and six were studentship holders from the Empire Cotton Growing Corporation. Another student was in receipt of a scholarship from the Government of Ceylon, and two others were continuing their studies from last year. One of these was a scholar from the Punjab Government making a special study of cotton genetics.

Amongst the Special Students there were two agricultural superintendents from Montserrat and St. Kitts respectively, who came for a "refresher" course of about seven weeks, and, it is believed, benefited greatly by their stay at the College.

The post-graduate courses continued on the lines of last year but the system of organised field days was developed with great benefit.

Seventeen field days were organised during the session. A further development has occurred in the institution of a short series of lectures on the tropical diseases of cattle and veterinary hygiene. This was given by the Lecturer in Veterinary Science.

A proposal to establish short courses for sugar estate overseers and managers was brought forward and the possibilities examined in detail by the Academic Board.

The Diploma was awarded to the following students in 1927-28 :—

M. Aspiazu.
F. McG. Bain.
L. S. Birkett.
A. C. G. Palmer (First Class).
G. E. L. Spencer.

The Associateship was awarded to the following during the same period 1927-28 :—

M. Afzal, B.Sc. Agric. (India).
A. K. Briant, B.A., Dip. Agric. (Camb.).
J. E. Bruce, Dip. Agric. (Glasgow).
F. E. Buckley, A.R.C.S. (London).
G. Cowan, Dip. Agric. (Glasgow).
H. R. Hosking, B.Sc., A.R.C.S. (London).
E. W. Leach, B.Sc. (Reading).
A. H. Lewis, B.Sc. (London).
E. B. Martyn, B.A. (Oxon.).
J. H. Palmer, B.A. (Camb.).
H. A. Pieris, B.A. (Camb.).
N. V. Rounce, Dip. Agric. (Wye).
A. H. Savile, Dip. Agric. (Wye).
C. L. Skidmore, B.Sc. Agric. (London).
H. P. Smart, B.Sc. (Transvaal).
C. B. Taylor, B.Sc. (Leeds).
G. N. K. Turnbull, Dip. Agric. (Glasgow).
O. J. Voelcker, B.A. (Camb.).

* * *

Research and Investigation.

The need for more land has been urged for some time past. The area available for cultivation on the existing estate surrounding the College buildings is at most not more than 60, or 70 acres. It is becoming increasingly obvious that in the near future the whole of this area will be required

for that function of the College which is concerned with the training and instruction of students. Large areas are needed for students' problems and it is also necessary to grow as wide a collection of tropical crops as possible in order to facilitate training. Steps will therefore have to be taken to secure a suitable estate for research principally into biological problems. It will not be forgotten that the College has to take "its place in the chain of Empire Research Stations, and that the prosecution of such research as is here contemplated (*vide infra*) is not only of great agricultural importance but is also of great value to the advanced students themselves. They thus become inducted into the methods, and familiarised with the difficulties inseparable from the gaining of new knowledge." Furthermore, it should give a proper sense of the lasting value of the College to each individual, as a place to which he can turn for real help in the new problems and difficulties that will inevitably confront him in his subsequent career.

Progress of Research during the year.

Good progress has been made during the year under report. Work on the main lines indicated in my last report has been carried on, and in some, definite results are beginning to be obtained. Most of the research undertaken at this College is of a fundamental nature and this necessitates systematic work over a long series of years. Naturally, therefore, the information that is gained towards the elucidation of a particular problem is often of necessity gradual and cumulative.

Bananas.—The main object of this research is to obtain a type of banana, with desirable commercial qualities, that is immune or highly resistant to Panama Disease (*Fusarium cubense*). The research involves not only cytological work and an investigation into the genetics of the plant, but also a study of the problem both from a pathological and the physiological aspect. Thanks to the grant from the Empire Marketing Board both these latter branches of this research can now be taken in hand. The pathologist, Dr. C. Wardlaw, has already started work and has made a prolonged tour of the West Indian area with a view to studying the disease under varying aspects as a preliminary to detailed research. The Physiologist, Dr. L. P. McGuire, has also been appointed. He made some preliminary enquiries at Cambridge and elsewhere before taking up his duties in Trinidad. Meanwhile work on the Low Temperature Research Station buildings is being pushed ahead and it is anticipated, will be completed by the end of the year. Arrangements have been made with the Conservator of Forests whereby seven acres of newly felled Forest Reserve land have been planted with the special varieties of bananas that are likely to be required for the preliminary experiments. Fruit will be available in January by which time the cold storage chambers are likely to be ready.

Work on the genetics of the crop has continued under the Professor of Botany (Mr. E. E. Cheesman) and it has been found possible to allot more ground to him for an extension of his work. It is becoming increasingly clear that the work can only be directed rationally by the aid of cytology, and this branch of the investigation has so far resulted in the establishment of the chromosome numbers of several more varieties. The work is complicated as will be understood when it is stated that the hybrid G.M. x B2, which is a cross between a wild type with 11 chromosomes and Gros Michael with 16, has apparently a diploid number of 38 chromosomes.

Back crossing with the immune seedling G.M. x B2 has been continued, but the results are not promising. Other alternative lines of attack are being proceeded with. Several varieties are already now known to be immune to Panama Disease. Whether means can be found so to control their ripening processes as to render it possible to market them overseas successfully, remains to be seen. It will be possible to investigate these points when the cold storage arrangements are completed, since ship-hold conditions can then be simulated. Field tests on certain promising varieties are being conducted by the Professor of Agriculture.

Sugar - cane.—The family of self-fertilised B.H. (10) 12 seedlings are to be planted on a field of the St. Augustine Experiment Station by arrangement with the Director of Agriculture, since land is not available at the College. No two of the seedlings are alike, and remarkable morphological differences are observed. It will only be possible to examine the factory qualities of these individual seedlings when the new stools are ready for crushing. In the meantime, a definite scheme for Genetic research into sugar-cane has been drawn up by Professor Cheesman and has been submitted for approval to the Governing Body.

The College has continued to be vitally interested in the research side of the Froghopper problem. In addition to the soil investigations which are mentioned elsewhere, it has been found possible to test out cyanogas and the same insecticide mixed with lime in varying proportions. The froghopper attack last season was not severe, but sufficient numbers were present to enable an extended test of this insecticide to be made and the results were sufficiently encouraging to warrant the assumption that we have at least a means of controlling the pest if the proper executive arrangements are made, at the right time, by the cane growers acting collectively.

Work has been prosecuted on the biochemical composition of parts of the sugar-cane plant during daily periods under varying degrees of sunlight. It is believed that this work may have a bearing on the behaviour of the sugar-cane plant to froghopper attacks.

(*To be concluded.*)

SUGAR PRODUCTION IN ANTIGUA.

BY G. G. GIANETTI, M.A. (Cantab.).

PRIOR to the twentieth century comparatively little effort was made in the British West Indies to adopt modern sugar factory methods. The growth of Antigua's sugar industry, however, is of particular historical interest in so far as it was in this island that one of the first attempts was made, by erecting a sugar factory at Gunthorpes, to improve existing methods of sugar manufacture. The history of this factory and of its early vicissitudes has already been told at length in the[1] West Indian Bulletin, but it may be of interest here to review briefly the chief events which led to what proved to be and is still a very successful enterprise.

While the matter had been the subject of many discussions, it was not until the West Indian Agricultural Conference of 1900 that prominence was given to the subject of central sugar factories and that a definite attempt was made to influence public opinion towards their possibilities. It must be remembered that, at the time, the manufacture of sugar in the smaller islands was carried on in small factories making muscovado sugar (*i.e.*: sugar made by open pans heated directly over open fires, whereby a soft brown sugar, having relatively small crystals, was produced). The main defect of these small factories was that the mills used for crushing the canes were small and inefficient as they only had three rollers and were capable of expressing only about 50 to 60 per cent. of the juice from the canes as against the present day 90 to 98 per cent. Also, muscovado sugar was being disposed of with increasing difficulty and refiners were showing marked preference for the types of sugar produced in vacuum pans which had gradually been introduced in Barbados, Antigua and St. Kitts.

As was pointed out by Sir Francis Watts[2] in a paper which he read at the Agricultural Conference, the West Indies could be divided into two groups, those in which the conditions were eminently favourable to the production of canes rich in sugar and those which, working under certain disadvantages, were producing canes of somewhat low sugar content. Barbados, the Leeward and Windward Islands were included in the first group, British Guiana and Trinidad in the second, whilst Jamaica was said to fall between the two. It was shown that in the colonies of the second group the agricultural disabilities had been remedied by the introduction of machinery of an improved type and by the application of the best methods which engineering and scientific skill could suggest at the time, whereas in the colonies of the first group where processes of extraction were rendered easier by the excellent quality of the canes, the muscovado system with all its defects and losses, had come to stay.

With low prices for sugar, however, it had become imperative to reduce costs of production, especially as plantations which had up to that time depended on primitive and wasteful processes could no longer, in average seasons, place sugar on the market at a profit. The disadvantages of the muscovado system were consequently pointed out in detail and the adoption of modern methods which included high crushing, multiple effect evaporation and crystallization in vacuum pans strongly advocated. A further argument put forward was that if the muscovado system with its enormous loss of material and low quality of produce could hold its own, or nearly hold its own, it followed that the prevention of these losses would convert the sugar industry in those places into a more or less safe and remunerative one. This argument gradually found favour with the planters and after much hard work on the part of the original promoters and many difficulties which were eventually overcome the Antigua Sugar Factory was opened in 1904.

The Antigua factory started with a capital expenditure of over £45,000 of which £15,000 had been contributed from a Parliamentary grant in aid of the sugar industry of the West Indies. The remainder of the capital was supplied by shareholders forming the Factory Company and a co-operative arrangement was made by which the Company agreed to build and run the factory, while eight estate proprietors agreed to grow and supply the canes for a period of 15 years on a profit sharing basis. The Company also agreed to provide reasonable railway facilities for the transport of canes. For every 100 lb. of canes delivered the estate proprietors were paid the equivalent price of $4\frac{1}{2}$ lb. 96° sugar crystals. Should this price be less in the aggregate than at the rate of 10s. per ton of canes, any profits remaining after paying working expenses, interest on capital and a reasonable contribution to sinking and reserve funds, were first to be applied to bringing the payment up to 10s. Any profits left over after this had been done were to be divided equally between the shareholders and the estate proprietors. Canes were also to be purchased by the factory from outside estates and from peasant proprietors on a bargaining system which worked out at an average of $5\frac{1}{2}$ lb. of sugar per 100 lb. of cane. The factory was also under an obligation to the Government to purchase such peasant grown cane as was offered. Although modifications have been made, the present contract system is based on the original plan which worked without any difficulties for the first 15 years.

Originally the factory was only planned to turn out 3,000 tons of sugar but this figure was exceeded after the first two years of working, and with the help of additional capital and modern equipment the factory's production of sugar which was naturally subject to seasonal variations increased rapidly and reached the high figure of 19,794 tons in 1927.

The Gunthorpes factory has without doubt served to demonstrate the possibilities of modern sugar-making in small places. Its influence was not confined to Antigua, as the information gained in its operation was widely disseminated

and thoroughly discussed, as was the intention of the Government in giving its financial aid. In consequence of this, the development of similar factories was considered in other islands and a well equipped factory was established in St. Kitts by the group of capitalists who later also developed the Usine Ste. Madeleine in Trinidad. The publication and discussion of results obtained also stimulated the plantation owners of Barbados who made substantial improvements in their small sugar factories and established small factories embodying modern methods of sugar production. The Antigua Sugar Factory was in a very real sense a pioneer one and it may be generally admitted as having amply fulfilled the expectations of its promoters.

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GOLD COAST COCOA.

According to the Acting Director of Agriculture the determination of the yield of individual cocoa trees has been continued and also the trials of yield from definite areas at all Experiment Stations. The voluntary system of examination of cacao at the ports is still in existence and various investigations arising out of the work have been carried out. These investigations are chiefly concerned with the various defects which have been noted, and comprise (1) the character of the moulds which form within the bean and their classification; (2) the standard of hygroscopic moisture and its relation to mould incidence and its variation with the humidity of air; (3) the seasonal variations of the various defects as shown by the varying percentages contained in the samples at different times in the year; and (4) a mathematical definition of "plumpness" in cacao beans has been attempted.

Investigations into the effect of the sea passage on cacao and into the effect of storage, together with the life histories of the insects attacking stored cocoa beans, have also been made.

The work on pod-disease and on Sahlbergella recorded in *Bulletins* 6 and 3 respectively, of the Department of Agriculture has been continued further.

A map showing the distribution of cocoa throughout the country, based on railway shipments, export figures and the personal experience of officers, was prepared and will form the basis for a systematic survey of such areas as presented difficulties during its preparation. The complete survey will gradually follow on from this commencement. — (*Bulletin of the Imperial Institute* Vol. XXVI, No. 4.)

THE WEST INDIAN CONFERENCE.

The West Indian Standing Conference which was recently held in Barbados was a distinct success and not only brought to light many problems of vital interest to the British West Indies, but also helped considerably to strengthen the spirit of co-operation of the several colonies represented. It is only to be hoped that immediate steps will now be taken to carry into effect those resolutions which the Conference was able to recommend in its advisory capacity. Of the two resolutions concerning agriculture, the first was with regard to the sugar industry and ran as follows: "The West Indies Conference desires to express the concern with which it views the present outlook before the sugar industry, and that the colonies urge the Imperial Government to take immediate steps to increase the tariff preference afforded to Empire sugars in Great Britain as the only immediately available means of reducing the heavy loss with which producers are faced, and of assisting them to tide over the present crisis." The Associated West Indian Chambers of Commerce meeting in Congress at Bridgetown on 23rd January expressed their own views as follows: "That while maintaining its belief in the desirability of the ultimate removal of all duties on Empire Sugar, this Association respectfully invites the Chancellor of the Exchequer to grant immediate assistance to the Empire Sugar Industry by reducing the duty on Empire Sugar by not less than 1s. per cwt."

It is now understood that a small Deputation headed by the Duke of Atholl will discuss the sugar situation with the Chancellor of the Exchequer. The Deputation's main argument will be that the tariff preference on British Colonial Sugar in Great Britain is negligible in comparison with that afforded to foreign Colonial Sugars in the markets of their mother countries.

The second resolution arose out of Mr. Evans' address. After giving a very clear exposition of the functions of the College, and thus removing many misconceptions with regard to its activities, he suggested that greater co-operation between the Agricultural Departments of the Conference Colonies might be desirable and the following resolution was passed accordingly: "That this Conference desires to express its conviction of the need of greater co-operation between the Agricultural Departments of the Conference Colonies and recommends that each of the Governments of the Conference Colonies should appoint its Director of Agriculture, or failing him an agricultural officer, to attend a meeting to be held at an early date under the Chairmanship of the Imperial College, with a view to devising means for co-ordinating local programmes of agricultural and veterinary research work, avoiding overlapping between the Agricultural Departments of the various Colonies and maintaining close touch between the local Departments and the Imperial College."

G. G.

TEA ROOT DISEASES.

The Treatment of Tea Root Diseases.

C. H. GADD, D.Sc., *Mycologist, Tea Research Institute of Ceylon.*

DURING the latter half of the nineteenth century, as a result of the classical researches of Anton de Bary, the Tulasne brothers, Berkeley, Kühn and others, the importance of fungi in the causation of disease in plants came to be recognised. Improvements in research methods followed, and accurate studies of life histories of fungi and the etiology of disease became possible. While the development of the science of plant pathology was proceeding, a better knowledge of the life processes of plants was also being acquired. As a result of these studies, we know that though many diseases are the primary result of attacks by parasitic organisms, others are the direct result of adverse environmental conditions, such as unfavourable water relations, deficiencies and excesses of soluble salts in the soil, &c. We may, for simplicity, classify those diseases, which result from attacks by parasitic organisms, as parasitic diseases, and the others as non-parasitic diseases.

The root diseases of the tea plant are no more the result of one basic cause than are diseases in general. That tea bushes will die as a result of drought, waterlogging of the soil and lightning must be within the experience of the majority of planters. In days gone by, it was usual to ascribe all deaths of tea bushes to "wet feet," "slab rock" and such like reasons. To-day, we know that much of the disease attributed to these causes was due primarily to the attacks of parasitic fungi. At the same time, we must realise that all disease is not of a parasitic nature, and that some is the result of a derangement of the life processes of the bush, brought about by adverse environmental conditions and by improper treatment through human agencies.

If a particular disease is the result of physiological causes, unconnected with attacks by parasitic organisms, the application of a treatment devised to control the spread of a parasite is obviously unsuitable. Treatment should aim at correcting or controlling the factors which cause the disease. No hard and fast lines can be drawn between parasitic and non-parasitic diseases so far as the resulting symptoms are concerned, though their treatments must necessarily be different. If a disease is to be treated correctly, it must first be diagnosed accurately.

Diplodia Disease.

The Diplodia root disease is one of the commonest diseases of tea in the low country of Ceylon. Its main characteristic is that the affected bushes, though apparently quite healthy before they are pruned, fail to recover after this operation. In some cases, the bush dies without putting out any new shoots; in others, a few belated, rather weak shoots are formed, but these die back. Bushes which survive this critical period recover, and there is no recurrence of the disease until next pruning time.

There are three points concerning this disease which are worthy of notice. (1) The disease occurs only after pruning. (2) It occurs most frequently at mid and low elevations, where the plucking rounds are most frequent and the pruning cycle is shortest. (3) The diseased bushes are scattered haphazard through the fields and are not confined to definite areas from which the disease spreads.

These facts suggest that the disease is due to physiological causes, probably associated with the operation of pruning. In that case, the organisms usually found on the roots of affected bushes are probably of secondary importance. This aspect of the Diplodia root disease has recently been the subject of study in Ceylon. The work is yet far from completion, but one or two tentative conclusions may be worthy of mention as they appear to afford a simple explanation of the causation of this disease. First, the roots of the tea bush appear to be the main reservoir for the storage of reserve food material. Secondly, healthy vigorous tea usually has an ample reserve of starch stored within the roots. Lastly, bushes affected by the Diplodia disease have no starch or, at best, very little, stored within their roots.

The real food of any green plant consists of carbohydrates, proteins, &c., which are manufactured by the plant for its own use. The manures which are applied to the soil form part of the raw materials from which the true food is made, and must not be confused with the finished product or elaborated food supply. The manufacture of the raw material into true food takes place mainly within the green leaves. Without leaves, a tea bush cannot manufacture more food, and is dependent upon its reserves for any new growth it may make.

When a tea bush is pruned, it is usually denuded of leaves. Consequently, the bush has to draw upon its reserves to support the process of growth which gives rise to new shoots and leaves. The deficiency of food reserves observed in the roots of Diplodia affected bushes is of importance; it appears to be a good reason why such bushes die after pruning. It also affords a reason why affected bushes do not respond to manurial treatment at pruning time. When the bush has formed enough leaves in which to elaborate sufficient food for its immediate requirements, it becomes independent of its stored reserves; consequently, no further trouble is experienced from this disease till the bush is pruned again.

This aspect of the causation of Diplodia disease requires careful consideration. Whether the deficiency of food reserves is the sole cause of this disease remains to be proved. The observed deficiency in specimens examined so far, however, is very suggestive.

The lighter form of pruning, which appears to be coming into favour in the low country districts, is possibly a step in the right direction as a preventive of this disease. Resting the bushes before pruning may also prove an effective remedy in fields known to be affected. Definite hard and fast rules for the conservation of food reserves cannot be laid down until more is known of the vital economies of the healthy tea bush. Further research and experiment are necessary before very definite recommendations can be made. If, as is expected, this disease is shown to be the result of physiological causes, the treatment must be designed to correct those causes rather than to control the spread of a parasitic organism.

The treatment of parasitic root diseases is directed mainly towards the prevention of their spread. For this reason the treatments are much alike. The first step is to dig out and burn the infected bushes in order to destroy the fungus which has invaded them. For several reasons it is usually not worth while to attempt to cure them. The bush is usually very seriously affected before one realises that anything is wrong, and then there is no hope of saving it. The disease is infectious; so while trying to cure a bush, other neighbouring bushes may become infected. Also the treatment would be surgical and include an examination of the whole of its root system to ascertain what roots are infected. This examination would have a very detrimental effect even on vigorous healthy bushes.

Critics of the "cut and burn" theory overlook the fact that, although fungus mycelium in some cases can be seen on the exterior of the roots, the fungus is also within the root tissues. Moreover, it is the fungus within the roots which does the greatest damage. The possibility of a discovery of some chemical substance, which when applied to the soil, will destroy the fungus without injury to the living roots, is somewhat remote. It would have to be a substance which would penetrate vegetable tissue (the roots) without injury, yet at the same time destroy the invading fungus which is also vegetable tissue. The surest way to destroy parasitic fungi is by burning the invaded tissues.

The seeds (spores) of fungi are very minute and are readily carried by the wind, like fine dust. When the spores find suitable lodgment, they begin to grow. A suitable lodgment for most of the tea root fungi is an old jungle stump. Then, the fungus permeates the stump and finally passes to the roots of adjacent tea bushes. For this reason, the removal of jungle stumps is a necessary step towards the eradication of root diseases from tea estates. All stumps are not equally good jumping off places for root disease fungi, but every stump is a potential starting point for some fungus or other.

The Brown Root and Ustulina diseases, caused by *Fomes lamaoensis* and *Ustulina zonata* respectively, are almost invariably associated with old stumps. On many estates the removal of old stumps has been, and is, systematically carried out. This practice has resulted in a marked diminution of root diseases generally and an almost complete eradication of Brown Root and Ustulina diseases from estates. These two diseases do not spread readily through the soil. A healthy root must be in actual contact with a diseased root before the former becomes infected. The removal of the diseased bushes and the stump from which the disease originated is usually sufficient for its control. Frequently, trenches are dug as a safeguard against further spread, but in the writer's opinion, if the digging out has been well done, the trenches are unnecessary.

The Poria and Rosellinia Diseases.

The diseases caused by *Poria hypolateritia* and *Rosellinia arcuata*, unlike the Ustulina and Brown Root diseases, spread very readily through the soil, passing from bush to bush, until large areas become affected. The bare patches one sees in tea fields, are frequently the result of one or other of these diseases. If the fungus is still active, dead or dying bushes can usually be found on the margin of such areas, which owing to further losses become larger annually. At this stage it is impossible to determine from what the disease originated. If from a stump, that stump has disappeared with the dead bushes which have been uprooted. The direction in which the disease is spreading is easily determined. Normally, it is along the radii of a circle, outwards from the centre, but sometimes the progress is more rapid in one direction than another.

The removal of dead bushes is not sufficient to control these diseases. A trench has to be constructed in order that the infected area may be completely isolated from the surrounding tea. In order to serve this purpose, the trench must be sited in front of the advancing fungus; otherwise it is valueless. In practice, at least two rows of apparently healthy bushes should be included within the isolated area.

If the dead bushes together with all woody material on which the fungus can feed are removed from the soil and if the trench is properly sited and kept open, further losses will yet be experienced. It is probable that every bush on the isolated patch will die during the course of the next few years. The fungus, being unable to pass the open trench, is restricted to the isolated area from which it is ultimately starved out, because the bushes on which it can feed are removed and burnt. What very often happens, particularly on hill slopes, is that the trench becomes silted up, and while in this condition, the fungus passes it and is once more at large. Under ideal conditions, the trench, if sufficiently deep, is an efficient barrier and stops the further progress of the disease. But, conditions are not always ideal for keeping trenches open; consequently, unless close attention is given to them for a number of years, the disease-causing fungus is liable to escape.

As all the bushes within the entrenched area are liable to succumb to the disease, is it not a more economical proposition to dig them out when the disease is first noticed and before the trench is constructed? Then, there is every possibility of starving out the disease and less risk of the fungus escaping beyond the trench. On hill slopes where it is difficult to keep trenches open, the removal of the surrounding tea bushes is to be advocated and the trench done away with.

If the tea, surrounding the dead bushes, is not cut out, an examination of the roots of adjacent bushes is certainly necessary. The fact that a bush may appear quite healthy one week, yet may be found to be dead of the Poria or Rosellinia diseases the following week, has given rise to the view that these diseases act rapidly. This, however, is not true, because the root system of a newly killed bush is usually badly rotted; this condition, however, cannot be produced in a week nor yet a month. Under laboratory conditions, Rosellinia takes about two months to kill a well grown seedling. A much longer period would be required to kill a well grown bush. It follows, therefore, that a tea bush may be attacked by a root disease for a long time before it shows any sign above ground that anything is wrong. Then the bush is so severely attacked that death follows after a very short period. The bushes, which adjoin those killed by Poria or Rosellinia, may appear healthy but usually their roots are attacked, often very severely.

That the apparently healthy bushes which adjoin a dead bush are not necessarily healthy explains why the trench has to be sited away from the dead bushes. It also explains why, when dead bushes only are removed, the disease progresses as far as the trench and destroys all the bushes within the enclosed area before it is stopped. Under such conditions the trench forms the sole line of defence. Unless the trench is well looked after and kept constantly open, the fungus is likely to pass it. Then another trench has to be constructed and the whole process repeated.

For these reasons, the examination of the roots of bushes adjoining dead ones is advocated. Preferably, these bushes should be dug out and at once examined and destroyed, as examination *in situ* is somewhat uncertain. If this procedure is continued until a complete ring of really healthy bushes, *i.e.*: bushes with no trace of the disease causing fungus on their roots, has been removed, there should be no necessity to construct a trench. The healthy tea is thus separated from the infected zone by a bare area and, if all roots, woody matter and such like material is forked out of the soil and burnt, the fungus is deprived of its food supply and is debarred from growing out and so reaching the healthy tea. This method of control is advisable on areas where trenches are difficult to construct and, when constructed, require much labour to keep them open.

It is inadvisable to supply such diseased areas for at least twelve months after the last dead bush was removed. This period may be increased with advantage. It is useless to supply an area while the fungus is active on the edge, though one sometimes sees this done. What happens is that the supplies come on well for a year or two, and then die of disease. Possibly, the fungus grows inwards from the margin, and possibly some fungus has remained alive in the soil. It is, however, a fairly common experience to find that supplies put into old Poria and Rosellinia patches, die of these diseases when they are about two or three years old, particularly, when the progress of the disease has not been checked.

How long these fungi can survive in the soil in the absence of obvious food material, like woody tissues, is not known definitely, but from general observations it is believed that the period does not exceed twelve months. For that reason, the treated areas should be kept fallow for at least a year before supplying.

In the past, the use of lime in the treatment of root diseases has generally been advised. From observations in the field its value against tea root disease fungi is very doubtful, and its use is not recommended.

Briefly, the treatment of parasitic root diseases in tea is directed towards the eradication of the fungus from the soil by the destruction of roots which bear the fungus, and by the removal as far as possible of the material on which the fungus may feed, in order to starve any remaining free in the soil. In addition, steps are taken to prevent the further progress of any of the fungus which may have escaped death by fire or starvation by separating the infected from the healthy areas by means of trenches or bare zones. Trenches, where possible, are preferable.

BITTER CASSAVA.

The bitter cassava (*Manihot utilissima* Pohl) has been cultivated in Brazil for scarcely 10 years. It is grown solely for the industrial utilisation of its roots in the preparation of meal. The roots are washed, triturated and pressed, then dried and roasted the same day, cooled and passed to the sorter for the elimination of large pieces and impurities, then the crude product is bagged. It may be kept thus indefinitely either raw or cooked. It only requires to be ground and bolted to produce meal for baking, confectionery, &c. For bread making 35-40 per cent. of this meal may be mixed with wheat flour. It has more uses than wheat meal and forms a health giving food, prescribed for the treatment of disorders of the digestive system. It contains 12.20 per cent. water, 1.80 per cent. protein, 4.20 per cent. cellulose, 12.30 per cent. dextrin, 0.92 per cent. fat, 65.78 per cent. starch and 2.80 per cent. mineral matter.

In 1926 the bitter cassava crop in Brazil gave a return of 12 million dollars.—(*International Review of Agriculture* Year XIX, No. 12.)

VITAMINS.

By Alfred Clark, F.R.C.S.,
Acting Government Pathologist, Trinidad.

II.—Vitamin A.

This food accessory was discovered in 1913 by McCollum and Davies and on account of its association with animal fats and oils such as butter and cod-liver oil was called "Fat-soluble A" to distinguish it from the other known vitamin "Water-soluble B." In the first studies of its effects there was much confusion with those due to vitamin D which is also associated with fats and which had not been separated from its fellow. As a matter of fact it is the unsaponifiable residue of fats and not the fats themselves which contains the vitamin A.

It has recently been demonstrated that vitamin A gives a purple colour reaction with Antimony Chloride and attempts have been made to estimate the relative quantities of the vitamin in food substances by means of the depth of the colouration. It is thermostable in vacuo, but is readily destroyed by a combination of heat and oxygenation.

Although it has never been isolated, an interesting product very rich in A was prepared by Takahashi in 1924 to which he gave the name of 'Biostearin.' This body has the property even when contained in a sealed quartz tube of giving out radiations which affect a photographic plate at a distance in a similar way to X-rays and the radioactive metals such as uranium. This observation appears to be important, but further research along the line indicated has not received much attention, though the suggestion has been made recently that vitamins are not material chemical compounds at all but some unknown form of energy. At all events nothing definite is known about the chemical nature of the vitamin under consideration.

Although vitamin A is only produced by the metabolism of the vegetable cell it is abundantly stored in the animal body and the effects consequent upon its exclusion from the diet is not immediately seen but appears when the reserve store is exhausted. This reserve supply is deposited chiefly in the fat of the internal organs, especially in the liver, but the subcutaneous and omental fat also contain some. In the muscles there is little or none so that lean meat is not of much value as a source of the vitamin.

In the vegetable world it is found principally in association with chlorophyll and the greener the vegetable the richer the supply of vitamin A. Spinach is very green and very rich and in the case of cabbage or lettuce the outer green leaves are certainly more rich in A than the etiolated leaves of the heart.

Tomatoes, tannias, yams, pineapples, bananas and the germ of cereals are good sources. Skimmed milk, whether tinned or fresh is wanting in it.

With regard to the vitamin A content of milk, upon which the supply for the suckling of course depends, it is important to remember that unless the mother's diet contains a sufficient quantity, her milk will be deficient and the suckling's health will suffer accordingly. Neither maternal solicitude nor a "bottle of medicine" is able to supply the lack.

With regard to the synthesis of the vitamin by plants, Heller has made experiments with seedlings grown in sunshine, in ultra-violet light and in the light of the Mazda lamp. He finds that the amount of vitamin produced under these different circumstances, tested by the growth of rats, is greatest in sunlight. He also states that seedlings grown in darkness synthesize a small amount, but this is denied by other experimenters.

The richness of summer vegetation in A as compared with winter growth results in the observed superiority in food value of the dairy products of the summer season over the produce of the same herd during the winter.

That a deficiency in the supply of vitamin A characterizes the dietary of the poorer classes in most countries is certain and the tropical colonies offer no exception to the rule. The use of vitamin-free vegetable oils and fats as substitutes for cream, milk and butter is very general and indeed inevitable whilst the disproportion between the price of good, fresh dairy produce and the average daily wage continues. Even if the standard of living could be raised it is doubtful whether the production of sufficient milk and butter for the vitamin needs of the population of the world is possible. Fortunately the liver-oil of animals such as the sheep and ox contains from 200 to 1,000 times as much vitamin A as is contained in the same quantity of a good average sample of butter. It should be possible therefore to put on the market butter substitutes, such as margarine, which have been brought up to the standard of good butter so far as vitamin value is concerned, by the addition of animal liver oil at a price within the reach of most people and in unrestricted quantity.

The physiological effect of a lack of vitamin A in the diet is a profound interference with the normal metabolism of the body. In the first place there is a complete arrest of growth and after a short interval changes occur in the epithelial and endothelial structures of the body with an associated arrest or perversion of function. These histological changes are first apparent in the eye where a conspicuous process of keratinization of the cells of the cornea brings about a loss of clearness and a greyish, ground-glass appearance. This condition is called Xerophthalmia and arises in six weeks, more or less, according to the reserve store of vitamin A held by the animal at the time when complete deprivation commenced. It is used as a test reaction in the laboratory to ascertain the presence or absence of the vitamin in the food under examination.

Associated with this change there is a keratinization of the cells of the lachrymal apparatus and of the mucous membrane and glands of the lids, which causes a dryness of the eye and accumulation of epithelial debris amongst the eye-lashes.

In addition to the eye changes, changes take place in the skin and mucous membranes of other parts of the body. That of the lungs, gastro-intestinal tract and the urinary system being very constantly affected.

McCarrison has demonstrated the fact that stones in the kidney, urinary bladder and gall-bladder are an almost constant result of a prolonged feeding of animals on a diet partly wanting in vitamin A, whilst no stones were produced in any of the control animals, who received the same diet plus $\frac{2}{3}$ of an ounce of whole milk daily.

In Newfoundland and other countries where winter is prolonged and severe, signs of vitamin deficiency are common and the night-blindness which is found amongst the population is due to shortage of vitamin A.

Arrest of growth from this cause is so common amongst the poorer classes everywhere that the stunted child or adult fails not only to arouse our indignation but even to attract our notice.

This condition was admirably shown by the gigantic dietetic experiment reluctantly carried out by Germany during the war when the shortage of animal fats and fat-soluble vitamins was almost complete. The result was that in the towns every child's growth had been almost or quite arrested for four years or thereabouts. In a suburb of Cologne I noticed one little girl who was conspicuously healthy and well-grown by comparison with her pinched and stunted play-fellows. "Why are you such a big, strong girl, Lischen?" I asked. Her companions cried in chorus, "Lischen's father is the butcher!"

In villages where green vegetables were used as a frequent article of food the stunting was less. This will be referred to again in the consideration of vitamin B., which is also concerned in normal growth.

Another constant result of a lack of vitamin A is a lessened resistance to bacterial infections of all kinds and a consequent increase in the prevalence of diseases which are due to such infections. This is especially the case with pulmonary diseases. Probably much of the winter rise in the incidence of these complaints is due to the seasonal deficiency of fats and green vegetables during the months when gardens are bare and the cattle are stall-fed.

In the laboratory there is a striking difference in the susceptibility to lung diseases of rats whose diet is deficient in vitamin A and those whose food is adequate in this respect. The mortality from all causes amongst my rats in the animal house where they all receive a properly balanced daily ration is negligible—only one out of nearly 300 rats has died and that death was due to a puerperal accident, whilst 17-18 per cent. of the rats on experimental diets (which are mostly deficient in A) show pulmonary lesions post mortem.

Mellanby records his observation that puppies on a diet containing little or no vitamin A are much more likely to develop pneumonia than those that are properly fed. He goes on to say, "It is well recognised that rickety children are particularly prone to develop bronchitis and broncho-pneumonia and it would seem reasonable to suppose on the basis of animal observation that these respiratory diseases may occur in children as a result of a deficiency in fat-soluble vitamins . . . Moreover, it is quite possible that the catarrhs of the respiratory and alimentary tracts commonly met with in earliest infancy may be similarly associated with defective feeding of the mother during pregnancy."

That the popular idea that bronchitis and pneumonia are due to cold weather is a fallacy is shown by the fact that in Sierra Leone during 1927 there occurred, according to the Annual Report, 7,821 cases of these diseases, which is 9.7 per cent. of the total number of hospital cases treated. It can hardly be a matter of inclement weather in that colony. We must, I think, blame the cook.

That the composition of the blood is profoundly changed by a deficiency of A is evident from the marked reduction in the number of platelets which is a constant feature. This thrombopenia is accompanied by haemorrhages, usually numerous and minute, in different organs. It is interesting to note that similar consequences follow the irradiation of the animals by X-rays or radium.

(*To be continued.*)

GROUND-NUTS ROSETTE DISEASE.

Ground-nuts form the staple crop in the Gambia Colony, and the absence of an alternative crop renders its liability to 'rosette' (virus) disease of considerable importance (*Annual Report*, Dept. Agric. for Gambia Colony, 1927-28). Investigations show that the insect carrier is probably one or both of two species of Jassidae which are being determined. This carrier would appear to be most active between mid-July and mid-August, judging by the incidence of disease, and so far no other food plants than ground-nuts have been observed. Infection appears to be carried over from year to year by ground-nuts left in the soil, and though other means are probable it seems evident that infection is not carried in the seed. The most susceptible period is the first few weeks after germination, but rainfall at this time reduces the incidence of disease, probably by rendering the insect carrier less active. The effect of the disease is to stunt growth, increase empty shells up to 55 per cent., reduce the good nuts to about 36 per cent., or to render the infected plants barren. Control at present consists in destroying all plants showing signs of disease and all ground-nuts that germinate between the growing seasons, and also in sowing the crop so as to avoid drought so far as possible during the first few weeks of growth. Fertilizers appear to have no beneficial effect whatever. Three varieties have been raised which have a high degree of resistance to disease, but so far no fully immune variety has been obtained.—(*Nature*, Vol. CXXII, p. 938.)

CENTRIFUGAL CLARIFICATION.

The Centrifuging and Super centrifuging of Syrups and Molasses.

By R. H. Hurst, B.Sc., Ph.D., A.I.C.

These experiments were carried out on a small scale in the laboratory of the Usine Ste. Madeleine with the use of a Hamill centrifuge revolving at about 3,000 r.p.m. and a Sharples supercentrifuge revolving at about 36,000 r.p.m.

Syrup and B molasses were the samples chosen for centrifuging. Each sample was divided into several portions. One portion was heated to 90°C. (to reduce its viscosity) and spun in the Hamill centrifuge only, another portion was heated and spun in the Sharples supercentrifuge only, whilst a third was heated and spun in the Hamill centrifuge and then reheated and spun in the Sharples supercentrifuge. The molasses samples were diluted a little before supercentrifuging. Each product was subjected to as complete an analysis as time afforded.

The purities of the various products were as follows :—

SYRUP.

	Apparent Purity.	*True Purity.*
Before Centrifuging ..	82.53	84.06
After Centrifuging.. ..	83.22	84.33
After Centrifuging and Supercentrifuging	83.41	85.02
B. MOLASSES.		
Before Centrifuging ..	53.44	55.63
After Centrifuging.. ..	54.05	55.83
After Supercentrifuging ..	56.30	58.62
After Centrifuging and Supercentrifuging	56.51	58.94

A source of inaccuracy in the above results lies in the use of the Brix spindle for the determination of total solids. A comparison with the values given by the refractometer showed the following results :—

SYRUP.

	Spindle Brix	*Refractometer Brix.*	*Difference.*
Before Centrifuging ..	54.2	53.1	1.1
After Centrifuging ..	56.5	55.6	0.9
After Supercentrifuging	57.7	56.9	0.8
After Centrifuging and Supercentrifuging ..	60.1	59.5	0.6
B. MOLASSES.			
Before Centrifuging ..	81.5	76.8	4.7
After Centrifuging ..	82.34	77.8	4.54
After Supercentrifuging	74.12	71.7	2.42
After Centrifuging and Supercentrifuging ..	77.28	75.1	2.18

It seems probable that solids in semi-solution which are partly removed by centrifuging are to some extent responsible for the above differences, by exercising a marked influence on the specific gravity of the solution whilst making little or no contribution to the refractive index.

If, however, the refractometer Brix is substituted for the spindle Brix, there is still a very definite increase in purity, particularly on supercentrifuging.

The sludge remaining in the Centrifuges was collected and dried. The amounts of solids thus removed in the sludge were as follows :—

SYRUP.

	Weight of Material Centrifuged	*Weight of Dry Solids in Sludge.*	*Removed.*
	gms.	gms.	%
Centrifuged ..	14,567	46.35	0.32
Supercentrifuged	3,826	11.98	0.31
B. MOLASSES.			
Centrifuged ..	14,061	22.21	0.16
Supercentrifuged	3,824	161.78	4.23

Owing to the impossibility of exactly separating and collecting the sludge and to the fact that a single series of experiments were carried out, the results are presented simply as a rough indication of the efficiency of the centrifuges. It will be seen that the Hamill centrifuge was relatively more effective with syrup than with the much more concentrated and therefore more viscous molasses. The enormous speed of the Sharples centrifuge was, however, sufficient to overcome the natural immobility of the molasses and the remarkable removal of solids representing 4.23% by weight of the original sample was effected.

The following tables give the amounts of certain non-sugars in the various products, recorded in each case as a *percentage of the Brix.*

SYRUP.

	Before Centrifuging.	*After Centrifuging.*	*After Supercentrifuging.*	*After Centrifuging and Supercentrifuging.*
'Alcogel' ..	3.43	3.53	3.19	3.47
Pentosans ..	0.105	0.108	0.104	0.107
Pectins ..	0.028	0.017	0.014	0.004
'Total' Nitrogen	0.0633	0.0638	0.0782	0.0747
Ash ..	3.44	3.23	3.05	3.15
B. MOLASSES.				
'Alcogel'	5.37	4.82	3.60	3.44
Pentosans ..	0.178	0.187	0.110	0.129
Pectins ..	0.147	0.116	0.073	0.068
'Total' nitrogen	0.236	0.228	0.233	0.231
Ash ..	8.79	8.09	6.77	6.54

Consideration of these results leads to the conclusion that, apart from considerations of viscosity, the higher the concentration of the centrifuged material, the greater is the removal of colloidal material. It is to be expected that

in the concentrated molasses samples the colloid particles will be less highly hydrated and therefore less stable. This is seen particularly in the case of the pentosans, which are, on the evidence of this experiment, unaffected by centrifuging even at the enormous speed of 36,000 r.p.m. when in the relatively dilute sugar solutions represented by the syrup samples, but which are removed in appreciable amount by supercentrifuging the concentrated molasses solutions. Even at this very high concentration, however, pentosans appear not to be removed by centrifuging at 3,000 r.p.m. Pectins, on the other hand, are removed by each process from both samples. This confirms our previous conclusion that pectins are much less highly hydrated in solution and therefore much less stable than are pentosans.

A remarkable feature of the results is the fact that the supercentrifuged molasses samples yield as small an amount of 'alcogel' (acetic acid-alcohol ppte.), calculated as a percentage of the Brix, as do the syrup samples.

For the maximum removal of colloidal material, two antagonistic influence must be considered, namely, concentration and viscosity of the material centrifuged. For a particular temperature, which will of course be as high as possible, and a particular speed of centrifuging, there would appear to be a critical concentration at which the most effective removal of undesirable material may be experienced. The inter-relation of these factors will form the basis of a further investigation.

The nitrogen compounds appear to be little affected by centrifuging, the indication being that there is little or no protein nitrogen left at this stage of manufacture. The apparent increase in nitrogen content of the syrup on supercentrifuging is difficult to understand, and will be ignored unless the figures obtained are confirmed in further experiments.

The removal of insoluble 'ash' is satisfactory, particularly in the case of the molasses samples.

For the measurements of viscosity and surface-tension, each molasses sample was diluted to exactly 60 Brix and each syrup sample to 50 Brix. The results obtained were as follows :—

SYRUP.

	Before Centrifuging	*After Centrifuging.*	*After Supercentrifuging.*	*After Centrifuging and Supercentrifuging.*
VISCOSITY (Time of flow in seconds) ..	167.0	163.5	162.0	156.0
SURFACE-TENSION (Dynes) ..	52.1	(48.0)	51.7	52.4

B. MOLASSES.

Viscosity ..	798.5	746.5	710.5	679.0
Surface-tension	41.9	41.3	41.3	42.3

The progressive decrease in viscosity affords a very clear indication of the efficiency of the process. Surface-tension measurements, on the other hand, give no indication of the removal of tension-lowering material. There is, however, the probability that the samples were contaminated to a very slight extent with oil from the apparatus, and a more rigid control of the experiment will be necessary to ensure the reliability of surface-tension measurements.

Sludge was collected from the Hamill centrifuge after centrifuging syrup and molasses samples. This was washed as thoroughly as possible with warm water and then dried. The molasses sludge formed very sticky lumps which it was impossible to wash entirely free from soluble material. Incineration of the dried sludge gave the following results :—

HAMILL CENTRIFUGE ONLY.

	% Ash.
Syrup Sludge	58.13
Molasses Sludge	41.54

In considering the application of this process on a factory scale as a commercial proposition it must be remembered that with the use of larger baskets nothing like the speed of the supercentrifuge can be attained. The Hamill centrifuge probably represents about the maximum centrifugal force 800 to 1,000 times gravity that could be expected, but enough has been written to indicate the value of this as a clarifying process. It seems certain that, when engineering difficulties have been overcome, and when economic conditions become favourable, the installation of centrifugal separators will be adopted by most up-to-date factories.

SUMMARY.

1. Experiments on the clarification of syrup and molasses by centrifuging in a Hamill centrifuge revolving at 3,000 r.p.m., and in a Sharples supercentrifuger evolving at 36,000 r.p.m. are described.

2. Results of analyses of the purities and of the non-sugars of the various products are tabulated.

3. The results indicate the possibilities of centrifugal separators in sugar factories, either used alone or in conjunction with a filtration scheme.

The author wishes to express his indebtedness to Professor Scott and officials of the Usine Ste. Madeleine for the loan of the Hamill centrifuge and for permitting these experiments to be carried out in their laboratories.

A producers' company has been formed in Grenada to ship spices, coconut, copra, fruits, &c., grown in that island to the oversea market. It will begin operations with a capital of £5,000, but the producers are confident that as the concern develops its business the capital will be increased.

EARLY MATURITY IN COTTON.

By Dr. S. C. Harland.

Cotton Research Station, Trinidad.

It is often necessary to take off a cotton crop in the shortest possible time after sowing. In some cotton growing countries, *e.g.*: Turkestan, only a comparatively short season is available due to temperature limitations, while in the Southern States of America the advent of the boll weevil, and in the West Indies the incoming of the Pink Boll Worm have rendered it desirable to promote early maturity.

An analysis of the factors having to do with early maturity in cotton may therefore be of some service. These factors may be set forth as follows:—

1. Period taken by seed to germinate.
2. Rate of growth of main axis.
3. The node of the first sympodium or fruiting branch, determining time of first flower.
4. The time intervals between first nodes on successive sympodia, and from node to node along the sympodia.
5. Genetic liability to shed buds before first flower.
6. Genetic liability to shed buds and bolls during flowering period.
7. Susceptibility to diseases which cause shedding.
8. Prevalence of insects which cause shedding.
9. Time from flower to ripe boll.
10. Form of flowering and fruiting cone as affected by density of spacing.

These factors may be dealt with in order:—

Period taken by seed to germinate.

The time taken by the seed to germinate and show its cotyledons above ground is affected mainly by the temperature at the time of sowing. In the United States it takes about two weeks; in the West Indies only three to four days. Certain subsidiary factors of less importance come into play. The presence of fuzz on the seed coat of Upland probably tends to retard entrance of water into the seed coat, for Upland types with completely naked seeds as a rule shew quicker germination. Some species of Gossypium such as *Stocksii* and *Tomentosum* shew delayed germination, and often the seeds do not germinate for several weeks after sowing. Probably in the native habitat of these types the seeds are scattered on the ground during the dry season and germinate during the rains after an extended rest period. Vigorous and early germination is promoted by treatment with Sulphuric Acid for five minutes and subsequently selecting for planting seeds of high specific gravity, by discarding all those which float in water. This treatment eliminates defective and diseased seeds, and is of great value in ensuring a good stand. The main thing is to get a type which germinates strongly and rapidly and gets away quickly.

Node of first Sympodium.

The time of the first flower is determined by the interaction of these two factors. Cottons differ considerably in rate of growth of main axis; thus Sea Island grows much more rapidly than Bourbon in the young stages. Practically no accurate observations are available. Rate of growth is primarily genetic but is affected by environmental conditions. A well tilled and well aerated soil with optimum water supply and temperature conditions are needed for the maximum expression of the growth rate factors. The number of the node of the first sympodium is perhaps more important since it appears to be determined chiefly by the genetic constitution of the plant. An Upland plant will produce its first fruiting branch at nodes 6-9 above the cotyledonary nodes (counting the latter as two). This has been found to be the case both in the West Indies, and in a greenhouse in England. But whereas plants in the West Indies produce their first flower with striking uniformity in 49-52 days, similar plants in England with the same node number took 80-90 days to flower—due to a lower temperature and consequent retardation of the rate of cell division in the meristems. Sea Island, in the West Indies, has a node number of 9 to 13 with some variation in the mean node number from strain to strain, for example:—

> the mean node number of St. Vincent A N is 9.3 with a flowering time of 60.3 days, while that of B S is 11.2 with 64.2 days.

Tropical perennial cottons have very high node numbers—25 to 50, and thus flower in not less than three to four months. Correlation between node number and flowering time can be seen both in mixed populations of Sea Island cottons and also in the F2 of crosses between Upland (or other early flowering type) and West Indian perennial. It would be possible to select from such a cross, a series of pure strains with a graduated series of node numbers varying from six to say 30. Thus under a given environmental complex, flowering time can be manipulated within very wide limits, and when the plant breeder can utilise fully the knowledge which is being obtained on the genetic factors influencing node number, the adjustment of flowering time to a given environmental complex may have an important bearing on cotton agriculture. Experiments might be undertaken on the selection for rapid growth of the main axis, using say the F2 of a cross between Egyptian and Sea Island as a basis.

The Time Relations between Sympodial Nodes.

The cotton plant produces its bolls on a series of sympodia which spring from either the main axis or from subsidiary monopodia, of similar structure to the main axis. Diagram (1) below shews the time intervals between the fruiting nodes on a typical Sea Island plant.

From this diagram it will be seen that the time interval between nodes on a fruiting branch becomes longer as you get to the end of the branch,

DIAGRAM I.

The flowering cone of a typical Sea Island plant.

DAY OF FLOWERING. F.B DAY OF FLOWERING.

Node on Sympodium.							*Node on Sympodium.*					
6	5	4	3	2	1		1	2	3	4	5	6
						41	129	137				
				133	125	40						
						39	120	128				
				124	116	38						
						37	111	119				
				115	107	36						
						35	102	110				
				105	97	34						
						33	93	101				
				96	88	32						
						31	84	92				
				85	79	30						
						29	75	81				
				78	72	28						
						27	68	74	81			
			77	70	64	26						
						25	60	66	73			
		78	70	63	57	24						
						23	53	59	66	74		
		71	63	56	50	22						
						21	46	52	59	67		
		60	53	48	43	20						
						19	41	46	51	58	65	
	62	56	49	44	39	18						
						17	36	41	46	53	59	
	57	51	44	39	34	16						
						15	32	37	42	49	55	
	53	47	40	35	30	14						
						13	28	33	38	45	51	
	48	42	35	30	25	12						
						11	23	28	33	40	46	
51	44	38	31	26	21	10						
						9	19	24	29	36	42	49
47	40	34	27	22	17	8						
						7	14	19	24	31	37	44
42	35	29	22	17	12	6						
						5	10	15	20	27	33	40
	31	25	18	13	8	4						
						3	5	10	15	22	29	
		20	13	8	3	2						
						1	1	6	11			

and also as you go up the plant, and that a series of concentric cones can be drawn after any given number of days over which flowering has taken place. Under West Indian conditions the time from flower to ripe boll in Sea Island is 51 days, so that by adding the number of days to the first flower, plus 51 days, for each node on the plant we can state exactly when the crop on any type of cone will be over.

Whether much genetic variation exists in the rate at which the nodes are differentiated on the sympodia has not been definitely worked out, but there is evidently very little difference between Upland and Sea Island.

Shedding. (*a*) Buds.

If every node on the fruiting cone produces a bud which finally becomes a ripe boll, the form of the bolling curve will reproduce the form of the flowering curve, with a lateral shift of 51 days. It seldom happens, however, that every node in the fruiting cone produces bud, flower and boll. Certain strains constantly shed buds on the first few sympodia, or even shed the whole sympodium, but this tendency can be greatly minimised by continued selection of plants which produce their first flower on the first node of the first fruiting branch. Shedding of buds before flowering has been shewn to be correlated with shedding of bolls after flowering (unpublished observations). The shedding of a bud at the end of the sympodium is normal. The rate of growth of each sympodium slackens down in proportion to the drain on the food supply by tissues in the active stage of growth. Ultimately the sympodium ceases to elongate, and the terminal bud aborts, rendering the production of further nodes impossible.

The interesting phenomenon known as "facultative shedding" is found in tree cottons with high node number—the so-called monopodial types of Leake. Such cottons sown in June, produce their first fruiting branch at circa node 30, but all the buds are shed along the sympodia until about November, when with a surprising suddenness, the plant begins to hold its buds, and thenceforth practically none are shed. Facultative shedding was first described by the writer in St. Vincent, and has since been observed in a large number of monopodial cottons of both New and Old World types. No reasons have yet been advanced to explain facultative shedding. It may be a photoperiodic phenomenon, since the flowering time of such plants as the pigeon pea, which normally flowers only near the end of the year, has been shewn to be influenced largely by the relative length of night and day.

Facultative shedding may be of value in tropical countries where the heavy rainfall during the vegetative period provides unfavourable conditions for setting and maturing bolls, for on the whole it is desirable in these countries to have flowering at the extreme end of the wet season and the maturing of the crop in the dry season.

Shedding of either buds or bolls has a pronounced effect on the form of the fruiting cone. Shedding of buds results in the production of more buds at other points of active cell division, and shedding of young bolls has the same effect. That is, the plant has a certain food supply at its disposal, and if the bud or boll which is drawing this supply is lost, the supply will go to fresh buds and bolls. Thus if a plant be deprived of its flowers on the day that they open, the number of flowers produced will be increased by about 100 per cent., and the resulting crop when the flowers are allowed to form bolls, will not be less and may possibly be more, than if the plant had been allowed to fruit from the beginning. Writers who have considered

the flowering curve to be potentially indicative of the size of the crop have often overlooked this point. A big flowering curve, descending very slowly may merely indicate excessive bud and boll shedding, and a later compensation in the form of more buds and flowers. A flower, bud, or boll has to be considered from this point of view—would it have been there if some other bud or boll had not been shed? Until this factor has been duly weighed, it is beside the point to talk of every bud being a potential flower, or every flower a potential boll.

Shedding as the result of attack by stainers can take place in bolls up to three weeks old, and as the amount of food material lost is comparatively great, it is clear that the compensatory effect must be less. Loss of such large bolls may thus reasonably be put down as a real loss, and not adequately made up later. The real disadvantage of shedding is not that the buds or bolls shed are to be regarded as potentially lost, but that the buds or bolls produced in their places by compensatory growth are usually formed so late in the season as to be practically useless. Thus, in the West Indies, the latter part of the flowering curve is quite useless, for the resulting bolls are destroyed either by cotton stainers, pink boll worm, or both.

Time from Flower to Ripe Boll.

The number of days from flower to ripe boll varies from 30 days in some Asiatic cotton, to 51 days in Sea Island. This is in the West Indies, where temperature conditions are at or near the optimum. In a greenhouse in England, Sea Island was observed to take up to 70 days, and in the Southern States the maturation period of the boll has been observed to be much prolonged at the end of the season. Broadly speaking, however, this factor has very little influence on the maturity of the crop, and need not be considered further.

Form of Flowering and Fruiting Curve as affected by density of spacing.

It has been previously shewn that the form of the flowering curve can be predicted from the shape and dimensions of the flowering cone. The form of this cone, however, is a function not only of the genetic constitution of the plant, but of the amount of food available for each plant. By restricting the amount of food, we can modify the form of the cone. As an extreme case let us take a number of Sea Island plants grown in six-inch pots. Growth proceeds normally for the first three or four weeks, though the leaves are reduced in size. The first flower is produced at the usual node, and the first boll 51 days later. Since food supply is restricted the fruiting cone becomes as in diagram 2. In three-inch pots the fruiting cone would be more restricted, and would be reduced to say one boll per plant. Food supply, however, is restricted also as the density of population becomes greater and competition between plants become more stringent.

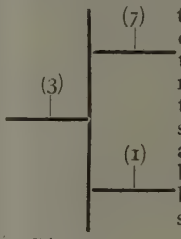

Diagram 2.

Increased density of spacing, therefore, tends to reduce the size of the fruiting cone to the limit of one boll per plant. In field population, however, another factor comes in with close spacing. Dense shade combined with excess water between the plants may induce shedding of buds before flowering begins, and compensatory growth result in the production of numbers of buds which by reason of food shortage, have no possible chance of coming to maturity. This diversion of food into places where it is not wanted, probably sets an economic limit to density of spacing for yield, and prevents the attainment of a fruiting cone of the desired size at high densities of population.

In actual practice, many experiments are needed before an economic balance is attained, and such experiments are urgently needed in most cotton-growing countries. Further they must be spread over a sufficient number of seasons to embrace the "modal" or most frequently occurring type of season. The above discussion may be useful for the planning of such experiments.

FIJI PINEAPPLE FIBRE.

A sample of pineapple fibre prepared from pineapple leaves by a local planter was commented as follows by the Director of the Imperial Institute. "This pineapple fibre is of excellent quality, being generally well prepared and of satisfactory length. Consignments of similar fibre would be readily saleable in the United Kingdom and would probably realise at least £50 per ton at the present time." The sample weighed nine ounces and consisted of two bundles of fine, fairly soft, lustrous fibre, varying in colour from pale brown to light green. The fibre, which had been well separated and cleaned, possessed good strength and had an average length of about three feet. Pineapple fibre is not a regular article of commerce in the United Kingdom, as it has usually been found that the cost of extracting it by hand is too high to make shipment profitable, and there does not at present appear to be any machine available which will do the work successfully In the circumstances, it is suggested that information should be furnished to the Imperial Institute as to the quantity of fibre which could be produced annually in Fiji by the methods at present available in the Colony, and the lowest price which would make the export of the product remunerative.—(*Fiji Agricultural Journal*, Vol. I, No. 1.)

TROPICAL WORLD NOTES.

Uganda.

The exports from Uganda during 1927 were: Cotton valued at close on £2,000,000, Coffee £170,000, Rubber £82,000, Sugar (chiefly refined) £16,800, Simsim (oilseeds) £14,000, as the chief vegetable production, but this by no means indicates the relative value of the crops grown. The sugar factory, established in 1925 at Lugaze to the north-west of Lake Victoria Nyanza, is now fully equipped and capable of producing 4,000 tons of refined sugar a year, and is being increased for a 5,000-ton output. A local market exists in Uganda and Kenya for the whole of this amount of sugar. A distillery has now been erected, which produces large quantities of power alcohol for local uses, and 638 gallons of methylated spirit were also exported.

The varieties of cane grown are given as (1) Soft yellow ones such as B. 3922, Sealey's Seedling and certain unidentified Ceylon ones, and (2) Striped Ribbon, Striped Bamboo and Tanna varieties; but the former have been found to be liable to an obscure "top-rot," and are giving place to the latter which are more resistant. Mosaic has made its appearance on one estate only, where the evidence points to its entry in 1926, as all earlier plantings are free and no canes have been introduced from outside for several years. It is hoped that the disease will be kept under control; the introduction of Uba is not desired because of the cost of changing the varieties and modifications in the factory, and the POJ varieties already obtained are being multiplied as fast as possible. During the year a number of varieties have also been received from the West Indies, which represent a great advance on the kinds hitherto grown in Uganda.

The area under sugar-cane in Uganda is given as follows: native fields 3,205 acres, Indian 3,685 plant canes and 1,420 ratoons, and European 260. —(*The International Sugar Journal*, Vol. XXXI, No. 361.)

* * *

Brazil.

The control which the Brazilian Government has continued to exercise over the coffee-growing industry in that country has again resulted in a firm market practically throughout the year. Actual crops were much heavier during the 1927-1928 season than during 1926-1927, and but for the protection which the Brazilian scheme gave to the industry prices would have fallen seriously. The daily receipts at Rio and Santos were governed by the then existing demand, the Government holding the balance in warehouses in the interior. In view of a crop of some 20,000,000 bags this necessitated holding a colossal quantity, which is put at the present time at nearly 14,000,000 bags, and there appears to have been no difficulty in financing this huge supply. Outside Brazil there has been an expansion in production, notably in Colombia and East Africa. Kenya coffee is attractive to United Kingdom buyers and increasing quantities have come upon the market here. During the first 11 months of the year arrivals in Europe amounted to 10,454,000 bags and those at American ports to 9,931,000 bags. These figures indicate a consumption for the year of about 22,000,000 bags. The world's visible supply on 1st December stood at 5,269,000 bags, compared with 5,365,000 bags the previous year, the quantity held by the Brazilian Government being excluded in both cases.—(*The Chamber of Commerce Journal*, Vol. LVII, No. 781.)

* * *

Colombia.

According to the Colombian Trade Review (Nos. 2, 3, 4 and 5, 1928) a very satisfactory development of Coffee growing and exportation has become possible in Colombia as a result of the advance in prices on the world markets, first in the period 1918-1919 and later in 1924-1925 as is shown clearly in the following table:

YEARS. (1)	New York Prices (Rio No. 7) cents per per lb.	London Prices. Central American s. d. per cwt.	Exports from Colombia quintals.
1912 ..	$14\frac{7}{16}$	16 11	559,933
1918 ..	$9\frac{1}{16}$	104 9	689,167
1919 ..	$17\frac{15}{16}$	121 3	1,010,265
1920 ..	$11\frac{15}{16}$	127 2	866,198
1921 ..	$7\frac{3}{16}$	82 8	1,407,080
1922 ..	$10\frac{1}{4}$	84 6	1,058,688
1923 ..	$11\frac{7}{16}$	78 9	1,236,397
1924 ..	$16\frac{13}{16}$	105 3	1,329,375
1925 ..	$19\frac{7}{8}$	129 6	1,146,882

At the present time, the export of coffee represents about 80 per cent. of the total exports of Colombia, and this product mainly contributes to the equilibrium of the trade balance of the country. There is an increase of more than 30 per cent. in the figure representing the value of the coffee exports of 1926, as compared with 1925, a 40 per cent. increase as compared with 1924, of 140 per cent. as compared with 1922, and of nearly 400 per cent. on the 1913 figure. Contributory causes of these advances are to be found in the reforms which have been successfully carried through the banking and monetary system and in the rise in the standard of living of the population of Colombia.

The present area devoted to coffee growing is estimated at 500,000 acres, the number of plants in bearing varying between 200 and 250 million while there is a reserve of another 50 million plants not yet in bearing. Coffee production in Colombia is mainly confined to small plantations belonging to cultivating owners who number about 200,000. The specialisation in coffee growing in Colombia is explained by the high commercial value of Colombian coffee on the world markets.

(1) *International Year Book of Agricultural Statistics*, Rome, International Institute of Agriculture.

COCOA IN 1927-28.

The world's requirements of cocoa during the past year failed to keep pace with the production, and a situation of oversupply was created which adversely affected values, especially in the latter six months, when there was a marked depreciation in values. After some ease in January firm markets were experienced until June. In July the market displayed signs of weakness and in August prices dropped 6*s.* to 8*d.* per cwt., West Indian and Central American varieties being chiefly affected. The main reason for the weakness was an excess of supply on dull markets, but the situation was aggravated by nervousness over the dissolution of the marketing agreement, which had been in force for some years, between four large firms in the export trade of the Gold Coast. With prospects of a larger West African crop, drooping markets were experienced during the remainder of the year, most varieties closing from 12*s.* to 13*s.* per cwt. below the prices ruling at the close of 1927. A notable exception, however, was Ceylon cocoa, which, owing to shortness of supply, experienced firm markets throughout the year, prices recording an advance of 10*s.* to 20*s.* per cwt. on the twelve months. The spot quotations in London of three varieties of cocoa at the close of each quarter of last year and at the close of the three preceding years are given below :—

	African West Coast	*Trinidad Good to Fine*	*Ceylon Good to Sup.*
31st Dec., 25	43*s.* to 45*s.*	66*s.* to 73*s.*	90*s.* to 100*s.*
do. 26	70*s.* to 71*s.*	78*s.* to 80*s.*	80*s.* to 87*s.*
do. 27	62*s.* to 65*s.*	74*s.* to 77*s.*	85*s.* to 93*s.*
31st Mar., 28	63*s.* to 64*s.*	76*s.* to 80*s.*	85*s.* to 100*s.*
30th June, 28	63*s.* to 68*s.*	76*s.* to 78*s.*	95*s.* to 115*s.*
30th Sept., 28	54*s.* to 58*s.*	64*s.* to 70*s.*	95*s.* to 112*s.*
31st Dec., 28	48*s.* to 52*s.*	61*s.* to 66*s.*	95*s.* to 114*s.*

An innovation in the home market was the inauguration on 21st May of the London Cocoa Terminal Market for trading in future delivery the basis of the contract being ten tons of fair fermented Gold Coast cocoa, ex-wharf London, the seller having the option to deliver certain other varieties. This was followed by the opening in September of the New Liverpool Cocoa Exchange, also for the purpose of trading in futures.—(*The Economist*, Vol. CVIII, No. 4, 459.)

Extended trials at Southend (England) have indicated (1) that East African Sisal hemp of No. 1 quality withstands the action of sea water just as well or even better than Manila hemp grade "J," whereas E.S.A. hemp of No. 2 quality is slightly inferior in this respect to Manila hemp ; (2) that the Manila hemp is superior to Sisal hemp in that Manila ropes do not increase in girth so much when immersed in water ; (3) that Sisal fibre sinks much more rapidly in water than Manila hemp. Further trials are in progress.—(*Bulletin of the Imperial Institute*, Vol. XXV, No. 4.)

REVIEWS.

Ethnology and Archaeology of the Malay Peninsula. By I. H. N. Evans. *Cambridge University Press*, pp. 164. Price 15*s.*

Concern with the native is a keynote of present-day British Colonial policy and successful administration must depend on understanding native mind and custom. Official systematic studies have been made by other countries and this is an essay in the same direction by an officer of the Taiping Museum, Federated Malay States. Mr. Evans makes important contributions to our knowledge of the non-Mahomedan tribes (the Negritos), of Malay crafts, and of the pre-history of the Peninsula. The work has been very favourably received by those competent to judge its scholarship. The reviewer is not in a position to be critical and can merely state that he has enjoyed reading a work that should be interesting to agricultural and particularly educational officers in tropical Africa and other parts of the Empire where the population is in a primitive state of culture.

G. W.

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Forest Products ; Their Manufacture and Use. By N. Courtlandt Brown, New York. *John Wiley & Sons*, Inc., Second Edition, 1927. Price $4. pp. 447.

This book presents an account of the manufacture and uses of forest products other than lumber. Its chapters deal with subjects such as wood pulp and paper making ; tanning materials ; veneers ; barrel staves ; turpentine and rosin ; hard wood and soft wood distillation ; charcoal ; boxes ; poles and posts ; fuelwoods ; shingles ; maple syrup ; rubber ; dyewoods and cork, with special reference to the United States of America. Its author is Professor of Forest Utilization at Syracuse University, New York. Nevertheless, certain tropical forest products are included in the descriptions. Thus, quebracho and mangrove barks are included among tannin raw materials, and rubber receives special consideration in one chapter of 13 pages. The dyewoods described include logwood, fustic, Brazilian redwoods, sandalwood and cutch, all products of tropical forests. The ground covered is extensive, so that the treatment of individual topics is necessarily somewhat restricted. A feature of the book is the commercial statistical tables included in almost every chapter. The book is printed on thick paper, and it contains many excellent pictures. It should serve as a handy work of reference to subject matter which is diffusely scattered throughout much extensive literature, and which has been selected and amplified by the author.

F. H.

Leaf-Mining Insects. By Needham, Frost and Tothill. *Bailliere, Tindall and Cox*, London, 1928.

The study of insects provides material for many interesting stories of life history, habits and adaptation. The book under review is much more than a book of stories, but the accounts given of the minute insects which live within the tissues of leaves of plants are very interesting stories which can be appreciated by the general reader as well as by the student and professional entomologist. The leaf miners are members of four large orders of insects, Coleoptera (beetles) Lepidoptera (moths) Hymenoptera (saw-flies) and Diptera (true flies). Leaf miners are larvae of insects which pass through the four stages of a complete metamorphosis, egg, larva, pupa, and adult. These larvae are specialized in their adaptations to their mode of living and these adaptations tend to produce a general resemblance among leaf miners, except that the maggots of the flies differ markedly from all the others. The book brings together results of observations and investigations accumulated over a long period of time by many observers and authorities on the subject. The reputation of Dr. Needham and his co-workers assures the scientific accuracy of the observations recorded, the book is well printed, and well illustrated and is a very welcome addition to the literature of an interesting group of insects, some of which are of economic importance.

H. A. B.

* * *

The Microbiology of Cellulose, Hemicelluloses, Pectins and Gums.—By A. C. Thaysen, and H. J. Bunker (pp. 363 with 23 figures). *Oxford University Press* 1927. Price 25*s*.

This book is significant in that it is an excellent attempt to collect and discuss a remarkable amount of information, which the authors have gained from an extensive survey of existing literature, and from their own research. Part I consists of a short account of the occurrence and properties of the organic compounds under consideration, and in Part II a condensed description is given of some of the organisms which are responsible for their decomposition. The remainder of the book deals with the parts played by certain organisms in nature, and with the ways in which others might be utilised in industrial processes (*e.g.*: in the manufacture of power alcohol, combustible gases, and organic acids from organic carbon compounds), if a greater knowledge of their physiology was obtained. Sections are devoted to the destruction of hemicelluloses and cellulose in the soil and manure heap, in the preparation of ensilage, and to the biological destruction of wood. Of tropical interest are the descriptions of the microbiological processes involved during the rotting of fibre plants, the injury of cotton and other fibres and fabrics by micro-organisms, and a new method of detection of this type of injury.

A. K. B.

BOOKS RECEIVED.

We have to acknowledge the receipt of the following books :—

AGRICULTURE.

Success on Irrigation Projects. J. A. Widstowe. *John Wiley & Sons* (*Chapman & Hall*), p. 154, 8*s*. 6*d*.

Principles and Practice of Horticulture. F. S. Galt. *University Tutorial Press*, p. 240, 3*s*. 6*d*.

The Tropical Crops. Otis W. Barrett. *Macmillan & Co., Ltd.*, p. 446, 17*s*.

The Principles of Underdrainage. R. D. Walker. *Chapman & Hall*, p. 224, 15*s*.

CHEMISTRY AND SOIL SCIENCE.

The Chemical Elements and Their Compounds. J. A. V. Butler. *Macmillan & Co., Ltd.*, p. 206, 6*s*.

The Fundamentals of Thermodynamics. J. A. V. Butler. *Macmillan & Co., Ltd.* p. 208, 6*s*.

The Geology of Venezuela and Trinidad. R. A. Liddle. *Messrs. T. P. McGowan* (*J. Murray*), p. 552, 33*s*. 6*d*.

GENERAL.

Unhappy India. Laipat Rai. *Banna Publishing Company*, p. 566, $3.00.

Histoire de la Guadeloupe sous l'ancien Régime. M. Satineau. *Payot, Paris*, p. 400.

Nelson's West Indian Readers, Book IV. J. O. Cutteridge. *Thomas Nelson & Sons Ltd.* p. 256, 2*s*.

MYCOLOGY.

Laboratory Manual of General Microbiology. E. B. Fred and S. A. Waksman. *McGraw Hill Publishing Co., Inc.*, p. 146, $2.00.

TECHNOLOGY.

The Realm of Rubber. H. H. Ghosh. *J. B. Daymond, Calcutta, p.* 252.

Junior Technical Electricity. R. W. Hutchinson, *University Tutorial Press*, p. 386, 4*s*. 6*d*.

VETERINARY SCIENCE.

Black's Veterinary Dictionary. Edited by Wm. C. Miller. *A. & C. Black*, p. 1082, 21*s*.

Diseases of Animals in Tropical Countries. C. R. Edmonds and G. K. Walker. *Baillière Tindall & Cox*, p. 408, 25*s*.

ZOOLOGY.

Locusts and Grasshoppers. B. P. Uvarov. *Imperial Bureau of Entomology*, p. 352, 21*s*.

The Principles of Applied Zoology. R. A. Wardle. *Longmans Green & Co. Ltd.*, p. 428, 21*s*.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Proposed modification of the Java sulphitation method.

The following summarises a paper by H. H. E. Sussbach. (Archief, 1928, 36, II, No. 48, 1187-1189.)

In closely studying the defecation-sulphitation method of juice clarification, the question arises whether one can remove a greater amount of the non-sugars without any great change in the installation, in order thus to obtain a better thin-juice and also obtain a more easily handled scum. At present the method of working most followed consists in heating the raw juice to about 70°C., in liming and sulphiting approximately simultaneously, at a slightly alkaline reaction, and to finish sulphitation at a final alkalinity lying between 7.4 and 7.8 pH, after which the juice is re-heated to about 104°C.; and sent into the settling tanks. Now one would expect from the high temperature combined with the slightly alkaline reaction to have as complete a flocculation of the colloids as is possible and a scum of good physical qualities, making it easily filtrable. But the thin-juice thus obtained is actually inferior to that obtained by carbonatation, which is to be ascribed to the less amount of the purifying agent used, namely lime. And one must not lose sight of the fact that the sulphitation method of clarification, in respect of the flocculation of the colloids, is carried out under totally different and much inferior conditions to those obtaining in carbonatation. Whereas in carbonatation the reaction is strongly alkaline at first, it is never so in sulphitation; and it is known that an important group of colloids only flocculate at a very strong alkalinity, of which use is made to advantage in the De Haan process.

In the ordinary method of sulphitation in which a thin stream of milk-of-lime reaches only to the uppermost layers of the juice, very probably leaving the lowest layers much less alkaline if not indeed acid (due to the SO_2 entering from beneath), and in which moreover the time during which the reaction persists is very short it is hardly possible to expect an effect similar to that in carbonatation. In some factories in which the dose of lime is added in two separate additions some improvement is effected. Since, however, in all juice clarification one has not so much to do with ion reactions as with physical-chemical processes which operate slowly, one must expect to maintain the alkaline reaction for some time, in which connection it may be mentioned that in the De Haan method the alkaline reaction lasts for some minutes. The permissible temperature at which an alkaline juice may be sulphited is 55-60°C., this corresponding with that to be maintained in carbonatation in order to avoid glucose decomposition, and at this temperature a group of colloids, which otherwise would remain quite unaffected, can be thrown down with strong alkalinity. In practice the necessary amount of lime must be known. If three litres of 15°Be. milk per 1,000 litres of raw juice represents the average amount of neutralization, then in order to have an alkalinity corresponding with that in the De Haan method (250 mgrms. CaO per litre) one must add about five litres of 15°Be. milk per 1,000 litres. Then after this addition, seeing that the colloids are not immediately affected, the juice must be left for five minutes at 55°C., after which, while gradually running in the remaining milk, the juice is sulphited off. Theoretically, a better clarification should thus be obtained with a better subsiding and a minimum glucose decomposition. Investigations on this method have been carried out by the author in the laboratory, and, later, on the technical scale, though, it is remarked, it is not new in principle, seeing that it or a similar procedure has been carried out at the Bandjardawa factory. It has been found that the resulting juices are clearer and the colour lighter than usual, besides which the after working was easier, and the colour of the massecuites better. The number of mgrms. of CaO per litre of clarified juice was low for sulphited juices, namely about 400.—(*Int. Sug. Journ.*, Vol. XXXI, No. 362, p. 102.)

* * *

Production cost of cane sugar in different countries.

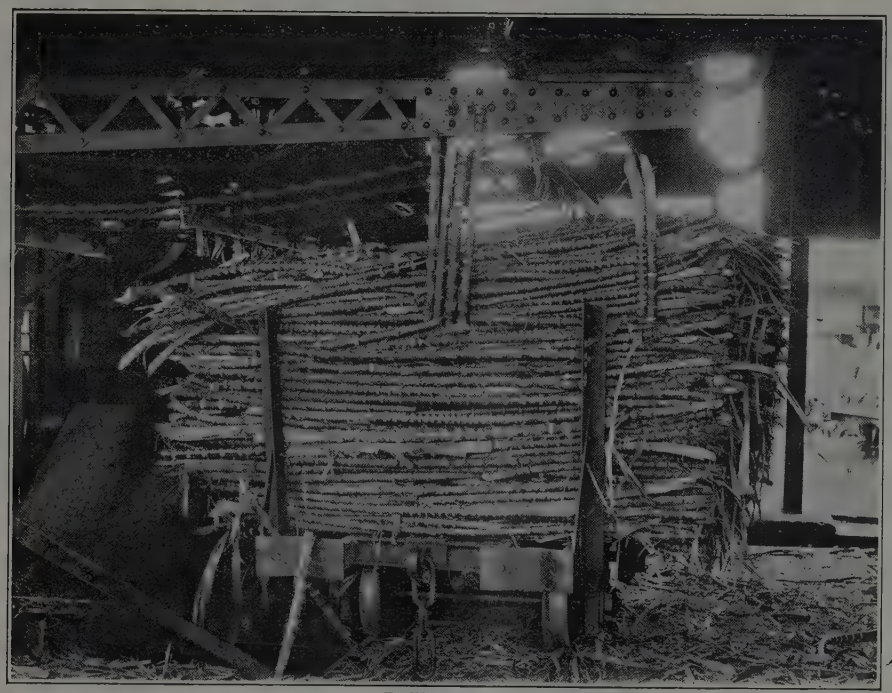
The following data on comparative costs of production are taken from studies of the International Institute of Rome. The Java figures, based on 13 factories and on the 1923 to 1924 crop, refer to cost per ton of sugar of 2,000 lb. (Circ. Mebd. No. 2068).

Cane, not including interest on agricultural capital	$ 17 11
Agricultural labour	3 95
Cane transport	6 02
Manufacturing	2 18
Upkeep of material and of buildings ..	4 54
Bagging	2 30
Insurances and different charges ..	2 60
Total of production costs, proper ..	38 70
Interest on agricultural capital ..	4 37
Administration	0 24
Sugar transports	3 07
Interest on capital	1 24
Commission	1 12
Brokerage	0 18
Taxes	3 08
Or total cost per ton of 2,000 lb. of raw sugar	$ 52 00

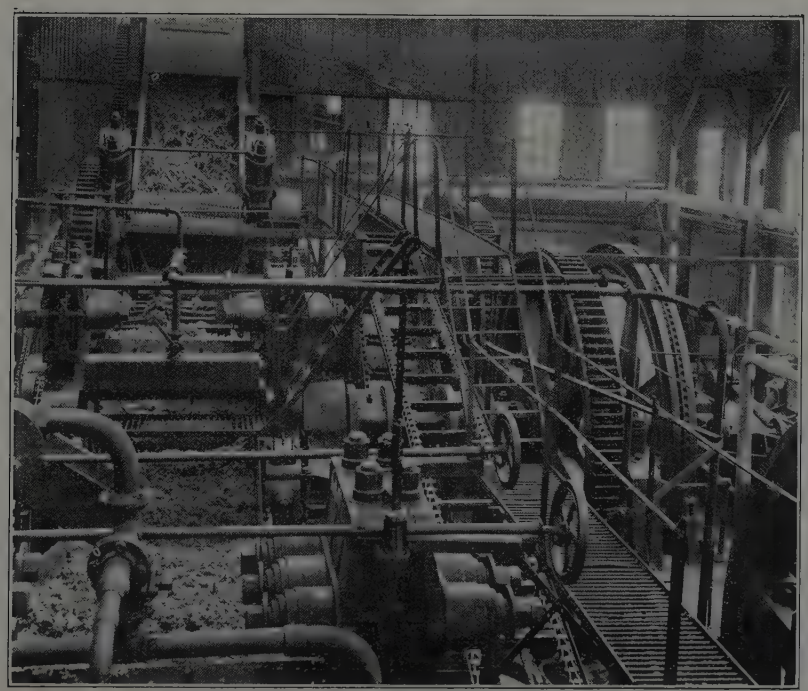
In Queensland, Australia, the costs are high amounting to $121 per ton of sugar; while in Natal, South Africa, an inquiry in 1926 gave a figure of $87. The Queensland figure refers to 1924.

According to these figures the production cost per short ton of raw sugar would be $38 in Java; $50 in Cuba; $68 in Hawaii; $87 in Natal; and $121 in Queensland.—(*Sugar*, Vol. XXXI, No. 1, p. 10.)

SUGAR PRODUCTION IN ANTIGUA.

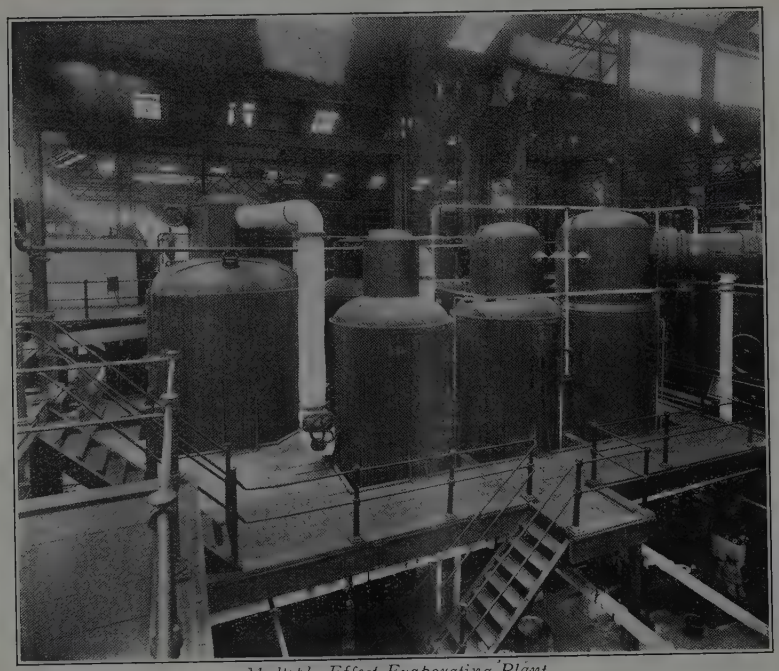


Raking Canes.



Milling Plant.

SUGAR PRODUCTION IN ANTIGUA.



Multiple Effect Evaporating Plant.

Bagging Sugar.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Fertiliser experiments with cotton.

A comprehensive survey of the fertiliser experiments with cotton performed by American experiment stations is contained in a review published by H. M. Steece in a Report on the Agricultural Experiment Stations, 1927. Thirty-six publications by the various experiment stations, covering a period 1919-1927, are considered.

In spite of the immense amount of work and study involved, the total results are somewhat inconclusive. Many of the earlier experiments were laid down before the modern mathematical methods of allowing for varying factors and for the interpretation of results were appreciated. In some cases allowance for the inter-dependence of the effect of various fertilisers is omitted. The diversity of many of the results obtained enforces the importance of local conditions in determining effects and yields. It enforces also the necessity for having carefully controlled experimental plots on each type of soil, and in each climatic region.

Further complications are introduced by the necessity of studying not only the type of fertiliser required, but also the optimum economical application and the effect of adding different fertilisers at various stages during the growth of the cotton plant. Again, local conditions play a large part in determining the results.

Some general conclusions have been reached. Nitrogen and phosphorus appear to be the chief requirements of the cotton plant. Potassium has little effect on the yield unless applied to a soil notably deficient in that element.

Annual addition of nitrogen is always beneficial, sodium nitrate being the most favoured form. Ammonium sulphate appears to be slightly inferior to the nitrate. At some stations the highest yields are obtained by using a mixture of sodium nitrate and an organic manure such as cottonseed meal. The estimate of the optimum application of nitrate varies from 100-300 lb. per acre, and it will probably vary according to the season at any one station. Experiments at Alabama suggest that it is advisable to delay the application of sodium nitrate until the crop is able to absorb it rapidly. The amount lost by leaching from the soil is thereby reduced to a minimum.

Superphosphate appears to be the most advantageous form in which to apply phosphorus. Ground rock phosphate gives smaller and later crops. An application of 200-300 lb. per acre is suggested.

Potassium applied in any form has approximately equal effect. Small applications are usually sufficient, large amounts delaying maturity.

The effect of liming a soil on which cotton is growing naturally varies with the type of soil treated. In most cases the increase in yield after liming has been small, and in one case a decrease followed.

The beneficial effects of alternating cotton with leguminous crops is shown by numerous experiments. It is claimed that a full rotation of cotton, cereals and legumes maintains soil fertility to an extent equal to that obtained by the use of a thousand pounds of mixed fertiliser. Probably a combination of cover crops and artificial fertiliser is the most satisfactory.

* * *

The nitrogen cycle in soil.

Dr. Carsten Olsen (*Comptes rendus du Laboratoire Carlsberg*), working on the significance of the hydrogen-ion concentration for the cycle of nitrogen transformation in the soil, has determined that ammonification can proceed in soils with pH values between 3.7 and 9.0 the process being most active when this value lies between 7.0 and 8.5. Nitrification can proceed in soils with pH between 3.7 to 8.8 the optimum being at pH 8.3 in soils rich in ammonia. Under natural conditions, in soils with pH between 4.0 and 8.0 the rapidity of nitrification is determined by the rate of ammonification, as the latter process limits the former. In strongly acid soil which is rendered alkaline by the addition of calcium carbonate, there takes place very rapidly a powerful nitrification, unless it is necessary to add inoculating soil from an alkaline reacting soil. Provided the nitrifying bacteria working in the acid soil are special kinds which cannot work in alkaline soil, the bacteria working in the alkaline soil must either be found in small quantities in the originally acid soil or be introduced in dust. The latter suggestions seem quite feasible, as the nitrifying organisms are not killed when soil containing them is dried out at ordinary room temperature, and transportation as dust from one locality to another is therefore possible.—(*Nature* 26th January, 1929, p. 144.)

* * *

Composition of bamboo.

Bamboo stalks, on disintegrating with chlorine dioxide and sodium sulphite, yield a fibre containing 70 per cent. of cellulose. This fibre, on extraction with soda, gives wood gum (xylan), a pentosan, whose amount is some 22.5 per cent. by weight of that of the fibre. In the short fibres, however, the xylan content is 39 per cent., so that it appears that the pentosan is located chiefly in the parenchymatous cells of the bamboo stalk. The epidermal cells contain cutin, which is a fat-cellulose compound.—(Hess and Ludtke, *Annalen*, 1928, p. 18.)

COLLEGE NEWS.

Dr. and Mrs. J. G. Myers sailed for British Guiana by the s.s. *Lady Drake* on the 6th March.

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Lord and Lady Stafford, paid a visit to the Cotton Research Station and the College on the 6th March.

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Sir William Robertson, K.C.M.G., Governor of Barbados, visited the College on 20th February and was entertained by the Principal and Mrs. Evans.

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Mr. J. M. N. Jeffries, the well known war correspondent of the *Daily Mail* was the guest of the Principal and Mrs. Evans and visited the College on 11th March.

* * *

Mr. R. R. Anson, Cotton Specialist, Fiji, has paid frequent visits to the College. He will be in the Colony for about five weeks and is at present making the Cotton Research Station his headquarters.

* * *

At a meeting of the Trinidad Science Club held on the 28th February, the Honourable Sir Francis Watts, K.C.M.G., D.Sc., delivered a lecture on "Notes on Agriculture in South Africa" illustrated by lantern slides. It was the first occasion on which an epidiascope, recently acquired by the College, was used with the slides.

* * *

Dr. C. Pratt, a member of the demonstration staff of the Imperial College of Science and Technology arrived in Trinidad by the s.s. *Cavina* on the 9th March. Dr. Pratt, who will make her headquarters at the College, is visiting Trinidad with a view to increasing her knowledge of general botany and particularly of tropical economic crops.

* * *

At a successful Agricultural Exhibition which was held in Port-of-Spain from 1st March to 3rd March, the College erected three stalls, which displayed the work of the Froghopper Investigation Committee, the new brand of Humming Bird Cane Syrup manufactured by the Experimental Sugar Factory, and the College publications.

* * *

Amongst recent visitors to the College were: Messrs. T. P. Mackenzie, F. A. Greer, M. I. Robertson, W. A. Robertson of the Indian Forestry Service, G. Rolleston, F. Berry and Archbishop Edward A. Parry, Colonel Sir A. R. Dick, K.B.E., D.S.O., and Mr. J. Gordon Miller, Director of Caroni Sugar Estates, Ltd.; Colonel Rowland F. Meyrick of Apleycastle, Salop, who is a breeder of pedigree stock; Professor T. H. Rolfs, Principal of the State Agricultural and Veterinary College, Vicasa, Minas Giraces, Brazil.

VISIT OF COLLEGE GOVERNORS.

Sir James Currie is the Chairman of the Governing Body and this is his first visit to the College and in fact to the West Indies. He succeeded the late Sir Arthur Shipley, who was the first Chairman of the Governing Body and who, a few months before he died, paid a three weeks visit to the College in February, 1927. Sir James arrived in Trinidad on the 31st January after spending a few days in Barbados where he attended, by invitation, several sessions of the Standing Conference of the British West Indies. He left the Colony on February 18th, and, with the exception of the last week end, which he spent at Government House as the guest of Sir Horace and Lady Byatt, he was in residence at the College staying with the Principal. Sir James found his time very fully occupied and expressed the greatest interest in the College life and its functions. He went extensively into the work of the various departments and paid particular attention to administrative matters. The intimate knowledge he has now been able to acquire of the inner working of the College will prove of incalculable value as it will naturally result in a complete understanding between the College executive officers and the Governing Body, since he has been able to establish personal contact with every member of the Staff.

In addition to College matters, much of Sir James' time was naturally taken up by the Cotton Research Station as he is Director of the Empire Cotton Growing Corporation. This Station is well staffed and extraordinarily well equipped and its progress and work were a source of gratification to him. He expressed the desire that there should be the closest co-operation between the officers of this institution and those of the College.

Sir James Currie addressed the whole College in his capacity as Chairman. His subject was entitled "The Career of an Agricultural Officer in the Tropics" and his views which were thoughtful and stimulating made a marked impression.

Much of his time was naturally taken up with administrative and financial matters and he attended a meeting of the Advisory Committee when these questions and also matters of future policy were fully discussed.

Professor T. B. Wood, the Drapers Professor of Agriculture and head of the Cambridge University Department of Agriculture, who was accompanied by Mrs. Wood, stayed a fortnight at the College leaving on February 23rd. His visit therefore partly overlapped with that of Sir James Currie. Professor Wood is now the representative of Cambridge University on the Governing Body and his knowledge and advice were of the greatest assistance. He was good enough to discuss matters of training and programmes of research with each of the heads of the scientific departments of the College and his great experience and knowledge proved very valuable. He was inclined to issue a warning

against too extensive a programme for research and advised concentration on particular and definite lines so far as "long-shot" research is concerned. He also addressed the College on "The history, policy and present functions of the Cambridge University Department of Agriculture," and his remarks were listened to with attention since the past history of the Cambridge Department and the early vicissitudes through which it passed, must inevitably have application to this College which is in process of developing so rapidly. Professor Wood was also good enough to address the Trinidad Science Club, which has its headquarters at the College, on "Animal Nutrition," and his unrivalled knowledge of this subject naturally enabled him to speak with the greatest authority. He pointed out, with truth, that this subject had received little attention up to the present in the tropics, and that a careful enquiry into the feeding values of tropical fodders and feeding stuffs was particularly needed.

The two Governors were so busy that they had not a great deal of leisure left to devote to social functions, but they nevertheless managed to visit Mr. E. A. Robinson's Rubber Estate at Non Pareil, the Government Stock Farm and the Ste. Madeleine Sugar Estates, where they were entertained by Mr. G. Westwood, the Manager. Sir James Currie also attended a field excursion to the River Estate in company with most of the post-graduate students and some of the staff, and was shown over the cacao experimental plots by the Director of Agriculture, Mr. W. G. Freeman. Professor Wood also managed to visit the Arena Forest Reserve where in co-operation with the Forest Department, bananas are being grown on a large scale for the Low Temperature Research Work.

The visit of these Governors was a complete success. They were favoured with weather above the average—in fact, what is sometimes termed "Director's weather" prevailed throughout their stay. Their visit and the great interest they evinced in all the aspects of College life has left a marked impression on all at the College and has had a most stimulating effect. When the executive officers of an Institution are situated 4,000 miles from their Governing Body, it is only by such visits that the slight misunderstandings and delays that are bound to arise, can be obviated and friction reduced to a minimum.

G. E.

ACKNOWLEDGMENT.

We have to acknowledge, with thanks, the gift of a copy of "Tropical Agriculture," by P. L. Simmonds, presented by Professor H. A. Ballou, and of a paper on "Trinidad and Oil Geology," by C. A. P. Southwell, presented by the author.

AGRICULTURAL EXCURSIONS.

Two Field Excursions, attended by the Post-Graduate and Special students and members of the Staff, were held during February.

On Wednesday, 13th February, a visit was made to River Estate, the cacao experimental station of the Trinidad Department of Agriculture. A long morning was spent going over the experimental areas, and particular interest was evinced in the shade and no shade and the spacing experiments. In the latter series the wider plantings are gradually overtaking the closer spaced plots so far as yields are concerned. Later on the budded series from high and low yielding parents were inspected, and also the series of seedlings from high yielding trees. A fruitful discussion arose on both these points, and the students were able to observe the technique and methods of recording employed.

The party were hospitably entertained to lunch by the Department, when thanks were suitably expressed by Sir James Currie and the Principal. Mr. Freeman gave a short lecture, illustrating with diagrams the experimental results of this station.

On Wednesday, 27th February, a visit was made to the Caroni Sugar Estates, and the party was received by Messrs. J. W. Arbuckle and L. Grant.

Particular attention was paid to field work. This estate is situated in the central alluvial plain, and the heavy ploughing is done by steam tackle, Fowler's plant being employed. Ploughing and harrowing by this system was observed, and also the methods of planting canes for the dry and wet seasons respectively, and the preparation of the beds. Afterwards cane reaping and carting were inspected and an opportunity was afforded of seeing the damage that is done by the large cane borer (*Castnia licus*), and of discussing the methods of control that are being adopted. In conclusion, a discussion on the methods of making pen manure took place, and the relative utility of its manufacture in covered pens and in open yards in the field, was gone into.

An instructive morning was spent, and the thanks of the whole party are due to Messrs. Arbuckle and Grant for the trouble they took to make the excursion a success.

G.E.

COLONIAL APPOINTMENTS.

The following appointments and transfers have been made by the Secretary of State for the Colonies during the month of January, 1929.

Lieut. A. W. Anderson, B.Sc., Superintendent of Agriculture, Nigeria.

Mr. D. A. Langdon, Produce Inspector, Nigeria.

Mr. T. D. Lloyd-Jones, M.R.C.V.S., D.V.S.M., Veterinary Officer, Nigeria.

Captain R. A. H. Tougher, Assistant Lands Officer, Tanganyika Territory.

Mr. J. R. Ainslie (Senior Conservator of Forests, Nigeria), Deputy Director of Forests, Nigeria.

Mr. C. F. Vetch (Conservator of Forests, Nigeria), Senior Conservator of Forests, Nigeria.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

Sugar.—Prices on the Home Markets ranged as follows (*c.i.f.* per cwt.):

	Foreign	*Preferential.*
	s. d.	*s. d.*
11th February ..	9 6	13 3
21st February ..	9 4½	13 1½
6th March ..	9 6	13 3
9th March ..	9 7½	13 1½

Messrs. C. Czarnikow, Ltd., state in their weekly report for 21st February, "more activity has been experienced in Sugar markets during the past week, but the increased volume of business passing has only been possible at reduced prices, values in New York having declined to the 1 1/16 cents *c.i.f.* output level, and on this side to 9*s.* 0¾*d.* *c.i.f.* for Sugar near at hand and 9*s.* 3*d.* *c.i.f.* for shipment. More inclination on the part of holders to dispose of a proportion of their stocks, owing to the near approach of the period of heaviest production, appears to be the chief cause of the recent weakness. In Cuba, production continues to make rapid progress, the total for the first half of the present month being over 700,000 tons, against 664,000 tons and 639,000 tons in the corresponding period of the two preceding years, whilst lack of warehouse accommodation is being spoken of in Porto Rico. Although the future position of the article still remains somewhat uncertain, there is no change in general sentiment. Those holders who have ample storage are showing more resistance at present levels, in the hope that more remunerative prices will be obtained later in the season. *The Weekly Statistical Sugar Journal* contains the following reference with regard to British India, "A heavy demand continues which could not be met. It appears that India has not yet covered all requirements and indications are that total exports will amount to about 1,200,000 tons, which would mean an increase of nearly 50 per cent. on last season's figures."

* * *

Cotton.—*The Liverpool Circular*, 15th February, states that the demand for cotton shows no improvement and that quotations show little change.

* * *

Cocoa.—The Government estimate of the main Accra crop is 15,000 tons above last year's output. Despite this the New York market continues quietly steady and buyers show interest in all available cocoa. Other grades have moved in sympathy although demand of Trinidads is somewhat easier. (*By courtesy of the Cocoa Planters' Association, Trinidad.*)

* * *

Coffee.—Of coffee there is 76,000 cwt. more in bond than at this time last year and while Brazilian seems to be hardening and both Jamaica and Costa Rica are steady markets, the drag of the large holdings upon the spot trade is felt. Quotations: Jamaica Mountain 210*s.*, Costa Rica Mid, 160*s.*, Kenya Good Mid, 135*s.*, Brazil Santos, 105*s.*—(*Times Trade and Engineering Supplement*, 23rd February.) East African coffee has sold well. Tanganyikas remain still on a very reasonable basis and compare most favourably for good value with any other growth now selling in the London market.

* * *

Tea.—Latest averages are 21*d.* Ceylon, 18.76*d.* India, 13.32*d.* Java, 17.92*d.* Sumatra, 13.37*d.* Nyasaland, 18.14*d.* Assam and 23.24*d.* Darjeeling. The Sumatra, Assam and Darjeeling averages show advance from the like date in 1928, but Ceylon and India have lost a little ground and so far into 1929 the total sales of tea in London have been rather small. The price of all tea sold has, however, been 18.52*d.* against 17.35*d.* last year.—(*Times Trade and Engineering Supplement.*)

* * *

Rubber.—For the week ending 21st February, Messrs. S. Figgis & Co. reported that the market had continued very active and that prices rose quickly about 1½*d.* per lb. above the previous week's quotations, but had since declined ½*d.* per lb. closing with a recovery of a farthing over the lower prices. America bought here and in the East considerably, and there has been further considerable speculative buying. Quotations for Plantation Sheet have ranged as follows: 2nd February, 11*d.*; 15th February, 11*s.* 0 7/16*d.*; 19th February, 1*s.* 0 5/8*d.*; 21st February, 1*s.* 0 3/4*d.*; 26th February, 1*s.* 1 3/8*d.*; 2nd March, 1*s.* 1 3/4*d.*; 8th March, 1*s.* 0 5/8*d.*

* * *

Copra.—The market is easier and West Indian *f.m.s.* is again lower at £23 17*s.* 6*d.* *c.i.f.* for February-March.—(*West India Committee Circular.*)

* * *

Bananas.—Owing to the cold weather there is practically no demand and the prices for Jamaicas are lower at £20 per ton (delivered) to wholesalers, and 9*d.* per dozen (carriage extra) to retailers. Brazilians are unchanged at £20 per ton delivered nearest railway station.—(*West India Committee Circular*, 21st February.)

* * *

Lime Products.—*Lime Oil:* The scarcity of Handpressed continues and no sales are reported. Distilled is firmer with sales at 30*s.* per lb. spot. *Lime Juice*: Concentrated is unchanged, but the tendency is again easier. (The last price was £25 *ex wharf* and *c.i.f.*). There is more enquiry for Raw and small sales have been made at 3*s.* 6*d.* to 3*s.* 8*d.* according to quality.—(*West India Committee Circular.*)